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Economics of Agricultural Management Measures in the Coastal Zone

Ralph E. Heimlich
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Economics of Agricultural Management Measures in the Coastal Zone.
By Ralph E. Heimlich and Charles H. Barnard, Natural Resources and Environment Division, Economic Research Service, U.S. Department of Agriculture.
Agricultural Economic Report No. 698.

Abstract

On November 5, 1990, Congress passed the Coastal Zone Act Reauthorization Amendments (CZARA), adding important nonpoint source water pollution requirements to the provisions of the Coastal Zone Management Act of 1972. The potential significance of the agricultural nonpoint source requirements in CZARA is twofold. First, it is the first federally mandated program requiring specific measures to deal with agricultural nonpoint sources. Second, it is being viewed as a model for stronger programs to deal with nonpoint source pollution. Based on an analysis of management measures included in EPA's national guidance and coastal farm profiles, annual costs of the proposed measures are typically less than \$5,000 per farm for most farm sizes. Exceptions are grazing management measures on larger farm sizes in the West, for which costs range up to \$75,539, and combined measures on larger dairy farms in all regions, for which costs range from \$9,606 to \$26,824. While coastal zone agriculture is quite different in both physical and economic terms from noncoastal agriculture, the general level of costs, impact on incomes, and relative differences between types of farms and size classes provide insight for a more comprehensive national program of nonpoint source control measures.

Keywords: CZMA, CZARA, coastal zones, nonpoint source water pollution, management measures, farmland, cropland, conservation, costs

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Summary

The Coastal Zone Management Act (CZMA), with the Coastal Zone Act Reauthorization Amendments (CZARA), is the first federally mandated program requiring specific measures to deal with agricultural nonpoint sources of pollution. CZARA is being viewed as a model for stronger programs to deal with nonpoint source pollution. Most coastal farms will need to spend only a small portion of their gross income on land and water management costs associated with CZARA. This report examines the economic impact of required management measures on farms in coastal areas.

According to the 1987 Census of Agriculture, 13.2 percent of U.S. farms and nearly 7 percent of U.S. farmland were located in coastal zone counties, where management measures are now required. More than half of coastal farmland is cropland. The costs of acquiring soil tests, nutrient recommendations, and pest management information are relatively inexpensive, costing less than 1 percent of gross income and operating expenses for over 90 percent of coastal farms. For 23 percent of farms affected by the CZARA, initial net farm income is negative before the management measure is applied. The additional costs of implementing the erosion management measure under CZARA will further aggravate these farms' financial situation.

A coastal area is any area that has coastal resources, such as wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and other fish and wildlife habitats. The Coastal Zone Management Act of 1972 (CZMA) established a program for resource protection and management in coastal areas. CZARA, passed by Congress in 1990, added important nonpoint source water pollution requirements to CZMA for States to continue receiving coastal zone funds. Nonpoint source water pollution occurs when soil erosion and agricultural runoff carry nutrients and sediments to surface bodies of water, such as lakes and streams. CZARA is the first federally mandated program requiring specific measures to deal with agricultural nonpoint sources of water quality problems. No direct cause-and-effect linkage between observed water quality conditions is needed for a State program to require the management measures. Critical coastal areas may need additional measures, beyond the basic management measures, to protect against current and anticipated nonpoint source pollution problems.

Any appraisal of the overall achievability of CZARA management measures to control agricultural nonpoint sources of water pollution is subjective. The small absolute dollar costs for most farms and the relatively low share of income and operating expenses required to comply with management measures are evidence that the measures are economically achievable.

While coastal zone agriculture is quite different in both physical and economic terms from noncoastal agriculture, the general level of costs, impact on incomes, and relative differences between types of farms and size classes provide insight for a more comprehensive national program of nonpoint source control measures. The effects of a nationwide nonpoint source program would probably be large enough to affect commodity supplies and prices, which must be taken into account in assessing the measures' overall economic effects.

Economics of Agricultural Management Measures in the Coastal Zone

Ralph E. Heimlich and Charles H. Barnard

Introduction

The Coastal Zone Management Act of 1972 (CZMA; 16 U.S.C. 1451 et seq.) was one of the important laws passed in the upswelling of environmental concern that occurred in the early 1970's. The CZMA established a program for resource protection and management in coastal areas, including the Great Lakes. To receive Federal funding for the program, States had to develop comprehensive programs of enforceable policies regulating coastal development and resolving conflicts in land and water use. Twenty-nine States and territories have federally approved programs for coastal resources such as wetlands, estuaries, beaches, dunes, barrier islands, coral reefs, and other fish and wildlife habitats. Each program is unique: State laws, regulations, permits, and local planning and zoning ordinances are all used to accomplish program objectives.

On November 5, 1990, Congress passed the Coastal Zone Act Reauthorization Amendments (CZARA; P.L. 101-508), adding important nonpoint source water pollution requirements to CZMA for States to continue receiving coastal zone funds. In Section 6202(a), Congress found that:

Nonpoint source pollution is increasingly recognized as a significant factor in coastal water degradation. In urban areas, storm water and combined sewer overflow are linked to major coastal problems, and in rural areas, runoff from agricultural activities may add to coastal pollution.

CZARA's Section 6217 requires that each State with an approved coastal zone management program develop and submit to the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) a coastal nonpoint pollution control program to "implement management measures for nonpoint source pollution to restore and protect coastal waters." In addition to agriculture, four other source categories were addressed by EPA based on water quality assessment data: silviculture,

urban runoff, marinas and recreational boating, and hydromodifications (dams, levees, and shoreline erosion).

Agriculture was identified as a significant nonpoint source of water pollution as early as the Section 208 areawide management plans required by the 1972 Federal Water Pollution Control Act amendments (NRDC, 1977). In the Water Quality Act of 1987, Congress enacted Section 319 establishing a national program to control nonpoint sources of water pollution, including agricultural sources. However, Section 319 has not had sufficient funds to address agricultural nonpoint sources on a voluntary, compensated basis and has not been actively pursued as a regulatory program.

The potential significance of the agricultural nonpoint source requirement in CZARA's Section 6217 (g) is twofold. First, it is the first federally mandated program requiring specific measures to deal with agricultural nonpoint sources.¹ Second, it is being viewed as a model for stronger programs to deal with nonpoint source pollution. Understanding the approach taken by EPA and NOAA in implementing CZARA's agricultural requirements provides insight into likely directions a similar program might take.

CZARA requires that economically achievable measures be implemented. EPA stated that economic achievability analysis identifies the classes or entities potentially affected by the management measures, assesses the entity's financial situation before and after implementing the measures, and deals only with the incremental costs above those required by other programs. No specific criteria were given for how large changes in economic well-being can be and still be economically achievable. EPA does not consider all site-specific conditions in assessing economic achievability.

¹Certain confined animal feedlot operations were previously defined as point sources requiring National Pollution Elimination Discharge permits under the Clean Water Act (Weinberg, 1991).

This report first examines the extent and nature of agricultural activity in the coastal zone. Next, the report describes CZARA management measures for agricultural activities and traces the process and thinking behind their development. Finally, the report reviews economic achievability of the proposed measures and presents an analysis of the economic impact of the measures on coastal farms.

Agriculture in the Coastal Zone

CZMA defined the coastal zone as the coastal waters and immediately adjacent shorelands. Section 6217(e) of CZARA now requires States to define the exact inland limits of the coastal zone necessary "to control the land and water uses that have a significant impact on the coastal waters of the State." NOAA developed an extensive definition of the coastal zone for use in reviewing proposed State coastal zone boundaries for CZARA implementation. This definition

includes watersheds draining to the coast adjacent to the shore and extending inland along estuaries to encompass the head of tide. Based on this NOAA definition, these watersheds are contained in 734 coastal counties for which agricultural data were assembled. This report also uses coastal zone States, divided into five regions to summarize some data and results (table 1 and fig. 1).

Farm Numbers and Farm Land

According to the 1987 Census of Agriculture, 275,012, or 13.2 percent, of U.S. farms were located in coastal zone counties (table 2). Nearly 67 million acres (28 percent of land area) are in farms in the coastal zone counties. Almost 7 percent of U.S. farmland is located in coastal counties and more than half (52.2 percent) of coastal farmland is cropland. Some 24.2 million acres of cropland are harvested, while the rest is fallowed, idled, or used for pasture. More than 25 million acres in coastal farms is grazing land, including all types of pasture, rangeland, cropland used

Table 1—Classification of Farm Costs and Return Survey records for economic achievability analysis, Coastal Zone Management Act, Section 6217

States by coastal regions—These overlap where a State is in more than one coastal region. States that do not currently have an approved coastal zone management program (Texas, Georgia, Ohio, Indiana, Illinois, and Wisconsin) are included in this analysis.

Northeast Coast—Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland.

Southeast Coast—Virginia, North Carolina, South Carolina, Georgia *, Florida.

Gulf Coast—Florida, Alabama, Mississippi, Louisiana, Texas*.

Great Lakes—New York, Ohio *, Indiana *, Illinois *, Michigan, Wisconsin *, Minnesota.

West Coast—Washington, Oregon, California.

* Does not have a currently approved coastal zone program.

Enterprise types—These are not mutually exclusive, overlapping where a farming operation fits in more than one type.

Cultivated crops—A farm producing any cultivated crop (irrigated or nonirrigated), excluding orchard, vineyard, or hay crops. Included if planted acres are greater than or equal to 20.

Irrigation—A farm using irrigation on any cropland, orchard, vineyard, or pasture. Included if irrigated acres are greater than or equal to 20.

Grazing animals—A farm having cattle for which the number of pasture acres per cow is greater than or equal to 1.

Animal waste concentrations—A farm having numbers of confined animals, including the following subcategories:

Cattle—A farm having cattle for which the number of pasture acres per cow is less than 1.

Swine—A farm having at least 100 swine.

Economic classes—A measure of size based on annual sales of crops, livestock, and products.

\$2,500-9,999

\$10,000-49,999

\$50,000-99,999

\$100,000-249,000

More than \$250,000



only for pasture or grazing, and grazed woodland. About 10 million acres of coastal zone farmland is woodland, accounting for 12 percent of U.S. farmed woodland. Coastal zone farms have a far greater percentage (30.7 percent) of "other" farmland, including

Table 2—Land use on coastal zone and U.S. farms, 1987

Land use	Coastal zone	United States	Share of U.S. total
			Percent
	-----Number-----		
Total farms	275,012	2,087,759	13.2
	-----Thousand acres-----		
Land in farms	66,968	964,470	6.9
Harvested cropland	24,213	282,224	8.6
Other cropland ¹	10,758	161,094	6.7
Total cropland	34,971	443,318	7.9
Woodland	9,811	79,894	12.3
Pasture and range ²	25,294	515,858	4.9
Other land in farms	20,543	30,929	66.4

Source: Census of Agriculture, 1987.

¹Includes cropland used only for pasture, failed, fallowed, or idled outside government programs.

²Includes cropland used only for pasture.

house lots, ponds, and roads, than do other types of U.S. farms.

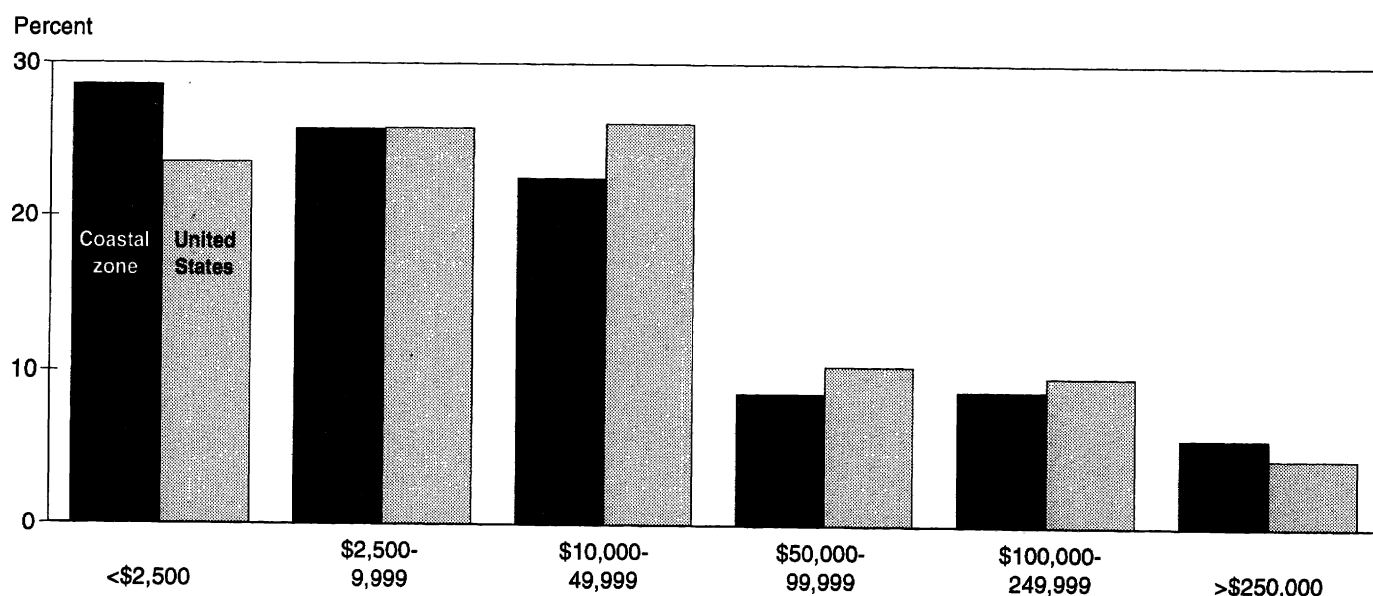
Size Classes

The average coastal zone farm (243 acres) is smaller than the average U.S. farm (462 acres). A larger percentage of coastal farms have less than \$2,500 in annual sales than for the U.S. (fig. 2). Smaller farm size, higher proportions of low sales, and higher proportions of "other" farmland are evidence that many coastal farms are not actively producing or are farmed less intensively than inland farms. However, the percentage of coastal farms with sales greater than \$250,000 per year is also greater than for the U.S. Sales per coastal farm average \$74,527, compared to \$65,165 for all U.S. farms.

Commodities Grown

Coastal zone farms account for 15 percent of total U.S. agricultural sales, including 11 percent of livestock and poultry sales and 20 percent of crop sales (table 3). The coastal zone counties produce 43 percent of the Nation's horticultural crops, including 52 percent of nursery and greenhouse crops, 48 percent of vegetables, and 33 percent of fruits, nuts, and berries. Coastal counties account for 19 percent of U.S. dairy sales and 19 percent of poultry sales. Certain kinds of livestock are more concentrated in coastal counties. The coastal zone has almost 18 percent of U.S. dairy cows, 15 percent of horses and ponies, and 14 percent of

Figure 2
Distribution of coastal zone and U.S. farms, by sales class, 1987



Source: U.S. Census of Agriculture, 1987.

hens and pullets. Sheep, hogs, and cattle on feedlots are less concentrated in coastal counties. Government payments to farmers in the coastal zone are only 6 percent of total U.S. payments. Low participation in commodity programs is partly due to the kinds of crop and livestock enterprises found in the coastal counties and partly due to the preponderance of smaller farms that do not participate.

Crop sales make up 58 percent and livestock and product sales 42 percent of total coastal zone sales. Horticultural crops, including vegetables, fruits, nuts, and berries, and nursery and greenhouse crops, are important, accounting for 37 percent of total coastal zone sales. Grain crops account for 10 percent of coastal

zone sales. Dairy (15 percent) and poultry (12 percent) are the largest livestock and product sales categories.

Conservation

Using a more inclusive definition of cropland than the Census of Agriculture, the 1987 National Resources Inventory (NRI; Soil Conservation Service (SCS) and Iowa State Statistical Laboratory, 1987) shows that almost 9 million acres of cropland in the coastal counties is eroding at rates greater than tolerable soil losses, thus requiring additional conservation treatment (table 4). This is a lower percentage (18 percent) than for the United States as a whole (23 percent). More than half of coastal cropland (56 percent) is planted to farm program crops that may be subject to U.S. Department

Table 3—Sales of agricultural commodities produced on coastal zone and total U.S. farms, 1987

Commodity	Coastal zone	United States	Share of U.S. total
	-----Thousand dollars-----		Percent
Sheep, lambs, and wool	34,836	791,219	4.4
Swine and pigs	902,718	9,890,644	9.1
Cattle and calves	1,713,487	35,876,720	4.8
Dairy products	3,003,913	16,029,195	18.7
Poultry and products	2,477,580	12,758,270	19.4
Other livestock and products	571,100	1,771,383	32.2
Livestock, poultry, and products	8,703,635	77,117,431	11.3
Corn grain	778,028	10,671,890	7.3
Wheat grain	157,997	4,827,887	3.3
Soybeans	678,827	9,125,434	7.4
Sorghum grain	101,818	943,684	10.8
Barley	14,513	711,241	2.0
Oat	19,370	223,134	8.7
Other grains	304,576	1,837,254	16.6
Grains	2,055,130	28,340,524	7.3
Vegetables	2,255,572	4,698,083	48.0
Fruits, nut, and berries	2,321,800	7,084,018	32.8
Nursery and greenhouse	2,979,624	5,774,391	51.6
Horticultural crops	7,556,996	17,556,492	43.0
Tobacco	456,748	1,745,417	26.2
Hay, silage, and field seeds	225,932	2,598,615	8.7
Other crops	1,497,269	8,690,037	17.2
Total crops	11,792,074	58,931,085	20.0
Total livestock and crops	20,495,709	136,048,516	15.1
Total government payments received	614,313	9,646,573	6.4
Net CCC loan total	416,211	8,333,195	5.0

Source: Census of Agriculture, 1987.

of Agriculture (USDA) conservation compliance provisions. Crops such as corn, soybeans, oats, and barley have a lower percentage of land devoted to them eroding at acceptable rates than do other coastal crops. Nonprogram crops, such as orchard, bush, and berry crops, other closegrown crops (such as flax), and other row crops, such as peanuts, vegetables, and tobacco, have a higher proportion of land eroding at less than tolerable rates than for the coastal zone as a whole.

Relatively little high-erodibility land is cropped in most coastal regions. Only 830,000 acres of cropland in the coastal zone used for 12 major program crops is highly erodible. This amounts to 2.7 percent of coastal zone cropland in commodity programs, compared with nearly a third of cropland planted to these crops in the United States as a whole.

Agricultural Practices

Almost 4.3 million acres of coastal zone cropland are irrigated, mostly in the Gulf and Pacific regions. The coastal zone has 10 percent of U.S. irrigated cropland,

more than proportional to coastal zone farmland or cropland. About 53 percent of coastal zone cropland and 6 percent of grazing land is fertilized, compared with 44 percent of U.S. cropland and 3 percent of grazing land (table 5). Coastal farms apply pesticides to a greater proportion of their cropland (80 percent) than for all U.S. farms (60 percent), accounting for 8 to 22 percent of U.S. cropland on which pesticides are applied.

How Will CZARA Be Implemented?

Just as CZARA nonpoint pollution programs do not replace the broader responsibilities for water quality in the Clean Water Act, coastal nonpoint pollution programs are not intended to eclipse either existing State coastal zone management programs or existing State nonpoint source management programs. Congress intended Section 6217 to tie together coastal zone management and water quality programs, enhancing their respective capacities to manage land use activity

Table 4—Cropland use and erosion in coastal counties, 1987

Crop	Eroding at rate			Share eroding	
	≤T ¹	>T	Total	≤T	>T
	-----Thousand acres-----			-----Percent-----	
Corn	9,658	3,045	12,703	76.0	24.0
Sorghum	1,615	237	1,852	87.2	12.8
Soybeans	5,439	1,957	7,396	73.5	26.5
Cotton	806	107	913	88.3	11.7
Wheat	1,912	471	2,383	80.2	19.8
Oats	407	117	524	77.7	22.3
Rice	1,111	84	1,195	93.0	7.0
Barley	386	162	548	70.4	29.6
Hay	6,815	596	7,411	92.0	8.0
Sugar beets	198	0	198	100.0	0.0
Summer fallow	325	149	474	68.6	31.4
Not planted	5,063	745	5,808	87.2	12.8
Orchards, bush, and berry	2,679	184	2,863	93.6	6.4
Other closegrown	937	101	1,038	90.2	9.8
Other row crops	3,467	773	4,240	81.8	18.2
Total	40,818	8,727	49,545 ²	82.4	17.6

Source: 1987 National Resources Inventory.

¹The tolerable soil loss level, T, is defined as the maximum rate of erosion that allows the productive capacity of the land to be maintained indefinitely.

²NRI cropland total is larger than Census of Agriculture because of differences in definition and coverage.

Table 5—Irrigation and agricultural chemical use in coastal counties and the United States

Treatment	Coastal zone	United States	Share of United States
	--Thousand acres--		Percent
Irrigated cropland	4,277	41,768	10.2
Cropland fertilized	18,552	195,135	9.5
Pasture and rangeland fertilized	1,668	15,938	10.5
Acres on which commercial fertilizer applied	20,610	211,073	9.8
Acres on which:			
Lime applied	1,840	12,586	14.6
Insecticides applied	8,681	68,823	12.6
Nematicides applied	1,255	5,931	21.2
Spraying for disease	2,328	10,467	22.2
Spraying for weeds/brush	14,535	171,288	8.5
Defoliants, growth regulators, fruit thinning applied	1,038	9,497	10.9

Source: Census of Agriculture, 1987.

to protect coastal waters and habitat (NOAA/U.S. EPA, 1993).

State Programs

States must develop a program to address minimum levels of nonpoint pollution control that are specified as basic management measures. State programs must also address additional management measures that may be required to attain water quality standards in critical coastal areas identified by the State in accordance with Section 6217(b)(1) and (2). Critical coastal areas need additional measures, beyond the basic management measures, to protect against current and anticipated nonpoint source pollution problems. In establishing critical coastal areas, NOAA/EPA guidance urges States to focus on areas in which new or expanding land uses may cause water quality impairment. This report, however, deals only with the basic management measures for which the State must:

- Identify those nonpoint source categories that impact coastal waters for which applicable basic management measures will be implemented and reasons why some subcategories should be excluded;
- Describe the basic management measures to be implemented and alternative measures selected in lieu of those in EPA's guidance; and

- Describe the procedures the State will use to ensure implementation of the management measures, including operation and maintenance of practices, enforceable policies and mechanisms, inspection procedures, certification, and monitoring.

States that fail to submit approvable programs to EPA and NOAA will suffer reductions in Federal grant dollars under the nonpoint source provisions of the Clean Water Act's Section 319 and coastal zone management program funds under Section 306 of CZMA. In FY 1991, the 29 States and territories with approved coastal zone programs received \$24 million in Section 319 grant awards. CZMA grant funds authorized under CZARA amounted to \$65 million in FY 1991, rising to \$108 million in FY 1995. States have 30 months (until July 1995) to submit a program for approval, 3 years from approval to fully implement basic management measures, and 8 years from approval to implement additional management measures. Grant reductions of 10 percent begin in fiscal year 1996, increasing to 15 percent in 1997, 20 percent in 1998, and 30 percent in 1999 and thereafter.

Management Measure Guidance

Section 6217(g) required EPA to publish guidance to the States for specifying coastal nonpoint source management measures (U.S. EPA, 1993). Management measures are defined in Section 6217(g)(5) as:

economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives. Final guidance was published in January, 1993 (U.S. EPA, 1993).

In a broad sense, CZARA will require farmers to take action to control nonpoint sources of pollution. However, the indirect linkage between Federal guidance, State programs, and requirements on farmers and the general guidance provided means that there is wide latitude for adjusting pollution controls to geographic conditions, site characteristics, and operator preferences. EPA's management measures guidance includes six elements:

- A description of a range of methods or practices that constitute the measure;
- A description of the categories of activities and locations for which each measure may be suitable;

- An identification of the pollutants that may be controlled by the measures and the water quality effects of adopting the measures;
- Estimates of the pollution reduction effects and costs of the measures;
- A description of factors that should be accounted for in adapting the measures to a specific operation; and
- Any necessary monitoring of the measure to assess its success in reducing pollutants over time.

In the legislative history, CZARA's principal architect Representative Gerry Studds makes clear that the management measure approach is technology-based rather than water-quality based. No direct cause-and-effect linkage between observed water quality conditions is needed for a State program to require the management measures. As long as a proposed management measure is technically and economically achievable and experts agree that it will generally reduce non-point pollution sources, a State program can require its adoption as part of the enforceable policies called for in the Coastal Zone Management Act of 1972.

State Implementation

The management measures guidance is accompanied by an implementation guidance document entitled *Program Development and Approval Guidance* issued jointly by NOAA and EPA (NOAA/U.S. EPA, 1993). Section 6217(b) requires State programs that "...provide for the implementation, at a minimum, of management measures in conformity with the guidance published under subsection (g) to protect coastal waters generally."

States have considerable latitude in designing a program that will meet EPA and NOAA approval. First, States can develop alternative management measures that are as effective as the management measures published in the guidance. Since the guidance is general and has few unequivocal requirements, any State program must be more specific as to which practices will be required under what circumstances. However, the burden of proof lies on the State to show that alternatives are as effective as the measures described in the guidance. Second, States may target their programs to their significant nonpoint sources if they can show that excluded sources are not significant. Agriculture may not be a significant source in some States, or specific agricultural source categories, such as eroding cropland or animal concentrations, may not be significant and need not be addressed. Third, States can phase in their programs over 3 years, attenuating economic

impacts over a longer time. Finally, States can adopt subsidized voluntary, educational, or market-based incentive systems rather than purely regulatory programs, to ensure implementation of the measures.

Methods and Data

CZARA requires that "economically achievable" measures be implemented. However, no clear definition of economic achievability was given in the legislation or exists in common administrative use. In the notice of availability for economic achievability analyses published in the *Federal Register* (Federal Register, 1992), EPA stated that economic achievability analysis identifies the classes or entities potentially affected by the management measures, assesses the entity's financial situation before and after implementing the measures, and deals only with the incremental costs above those required by other programs or above the costs incurred as part of current general practice. No specific criteria for how large changes in economic well-being can be and still be economically achievable were given.

In general, we assess the economic achievability of the management measures by estimating the direct costs of practices that would typically be used to achieve compliance with each measure. These costs are then compared with measures of farm well-being, such as gross and net farm income, operating expenses, and total farm and nonfarm income for each of several farm profiles representing the kinds and sizes of operations found in the coastal zone in each coastal region.

Costs of Management Measures

Cost estimates, stated in terms of average annualized costs, were compiled for specific practices discussed under each of the management measures. In most cases, the direct costs of installing or adopting the practices are estimated, but indirect costs incurred due to changes in the farm operations necessitated by adopting the practice are not estimated. For example, costs of testing and developing a nutrient management plan and savings from reduced nutrient applications are estimated. However, additional costs that might be incurred because of changes in the timing or form of nutrients applied are not estimated. Costs are incremental costs above those already incurred because of other program requirements, such as USDA's Conservation Compliance Program. The analysis does not include transition costs and learning curves not directly associated with changes in equipment costs. These costs are generally felt to be small and are part of farmers' normal adjustments to changing technologies.

Often, as in the case of grazing practices, the mix of practices that will be required can only be known in the context of the physical situation on the farm. In these situations, the overall cost of the measure is estimated from similar combinations of practices applied under the Agricultural Conservation Program (ACP) or Rural Clean Water Program (RCWP). Cost factors were developed on a unit basis (that is, per animal or per acre treated) and applied to the number of units present in each of the farm profiles. Since only a portion of the acres may require treatment, data showing the average proportion of acres needing such measures were developed from data in USDA's 1982 NRI.

Cost factors for some measures, such as the confined animal facility and erosion control measures, were calculated from cost estimates developed for EPA using more elaborate simulation or engineering cost models. For these, the cost of the measure is calculated from the net change in income per acre in the simulation or from the engineering cost estimate, as developed in separate reports. The resulting cost per acre or per animal is applied to the returns in the farm profiles in the same way as for other costs. State and Federal agency costs for technical assistance are not included. These costs of developing the prescription or plan for site-specific problems on affected farms would otherwise be borne by producers. Some State programs may develop means for recouping these costs from farmers. Specific assumptions for each measure are described in appendix A.

Cost-Share Considerations

Availability of cost-sharing for practices required under agricultural management measures was assumed in estimating the net cost of compliance to farm operators. Government cost-sharing was estimated to be the lesser of:

- The average cost-share percentage in each region based on ACP practices, or

- The annualized amount of a maximum annual cost-share up to the \$3,500 maximum customarily imposed by local soil and water conservation authorities, equal to an annualized \$411 at 10 percent interest over a 20-year useful life.

For the combined analyses, it was assumed that each component (effluent runoff, erosion control, grazing practices) would be applied during successive years, thus eligible for an additional \$3,500 maximum each year. If cost-share funds are not available to farm operators in the coastal area affected by these requirements as assumed, the cost of practices required under these management measures would increase and economic

achievability would be reduced. If ACP funding is reduced or redirected to other national priorities, coastal zone implementation costs will be higher.

No cost-sharing was assumed for the erosion measures because it was assumed that available cost-sharing would be used to meet conservation compliance costs under the Food, Agriculture, Conservation, and Trade Act of 1990. No cost-share was assumed on nutrient and pesticide information costs because these are not part of customary conservation programs. While there is currently a special practice (SP53) for these costs and there may be funding for such practices under the Water Quality Incentives Program or under Clean Water Act reauthorization, the conservative assumption of no cost-share was made. Also, no cost-share was assumed for irrigation flow metering and soil moisture probes.

The timeframe for arriving at the new condition, with measures fully applied, is not clear. States have 3 years from approval to fully implement basic management measures. Amortization of financing for equipment or structures required will generally take longer than implementing the practices.

Farm Profiles

This report uses profiles of farms in coastal zone States in a variety of enterprises. The profiles are based on data from the 1989 Farm Costs and Returns Survey (FCRS), an annual survey conducted by the National Agricultural Statistics Service (NASS) for the Economic Research Service (ERS) of the USDA. The 1989 FCRS provided detailed estimates of operating and financial characteristics for approximately 11,836 operations that sold or normally would have sold at least \$1,000 worth of agricultural products. Farms are selected from a list frame of medium to large farms and a complementary area frame to insure sample representation of smaller farms less likely to appear on lists. Multiplying each observation by an expansion factor yields an estimate of 1,734,814 farms in the United States.

Farm profiles were defined for each of five coastal regions, five enterprise types, and five economic classes, providing for a maximum of 125 different profiles (table 1). To conserve sample observations for statistical reliability, enterprise categories were not defined to be mutually exclusive. For example, a single farm could be represented as a cultivated crop farm, an irrigated farm, and a grazing cattle farm if it met the criteria for each enterprise in table 1. Most enterprises within a farm operation are highly interrelated. For example, feed and forage from crop and pasture activities contribute to the livestock enterprise, but sales, the value

Table 6—Farm profiles and farm numbers in coastal regions

		Economic class					
Coastal region	Farm type	\$2,500- 9,999	\$10,000- 49,999	\$50,000- 99,999	\$100,000- 249,999	\$250,000 or more	All farms
Number of farms represented							
Northeast	Cultivated crop	7,465	10,639	8,316	6,252	2,783	35,453
	Grazing cattle	-----					8,789
	Confined livestock						
	Cattle	-----13,012-----		5,493	4,657	1,968	25,130
Southeast	Cultivated crop	12,608	17,430	7,807	7,280	5,701	50,826
	Irrigated crop	-----4,138-----				1,300	5,438
	Grazing cattle	16,205	14,060	-----4,313-----			34,578
	Confined livestock						
	Cattle	11,356	5,234	-----4,592-----		2,204	23,386
	Swine	-----3,141-----		-----2,139-----		1,205	6,485
Gulf	Cultivated crop	16,609	30,670	12,198	9,823	9,004	78,304
	Irrigated crop	-----4,500-----			4,038	5,140	13,678
	Grazing cattle	59,820	54,610	13,166	5,467	3,267	136,329
	Confined livestock						
	Cattle	12,108	11,538	-----4,697-----		2,530	30,874
	Swine	-----					4,459
Great Lakes	Cultivated crop	38,340	98,212	60,373	62,538	21,301	280,764
	Irrigated crop	-----3,761-----				2,849	6,611
	Grazing cattle	11,847	22,548	9,500	-----6,668-----		50,563
	Confined livestock						
	Cattle	-----35,003-----		31,315	35,439	10,200	111,958
	Swine	-----10,736-----		9,162	11,622	5,854	37,374
West	Cultivated crop	-----11,762-----		5,960	8,182	8,935	34,839
	Irrigated crop	-----14,764-----		8,532	9,716	11,472	44,484
	Grazing cattle	-----15,331-----			3,405	1,751	20,487
	Confined livestock						
	Cattle	-----9,092-----		-----2,555-----		4,077	15,724
Total		221,889	355,767	189,247	186,754	102,877	1,056,533

-- Observations combined to provide sufficient sample to support statistically reliable inferences.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

of all products, and all costs are reported in one set of farm income measures against which economic achievability must be assessed.

A total of 8,964 observations on the profiles were available (not mutually exclusive), representing more than 1 million farm operations in States that have coastal

zones (table 6). This includes all States with currently approved coastal zone programs, States developing programs (Ohio, Texas, and Georgia), and States that do not have current plans for participating in coastal zone programs (Indiana and Illinois). Observations from the entire State are used because the number of observations from coastal zone counties alone would be too few for

statistical reliability. The direction and magnitude of possible bias introduced by representing coastal zone farm operations using State data are not known and cannot be assessed. Statistical reliability requires that at least 30 observations be used for confidence in point estimates and that coefficients of variation (CV) be computed for each estimate. The CV is calculated as the standard error divided by the mean, times 100, and is a measure of variability in the sample around the mean. Some profiles for some enterprises in some coastal regions did not have at least 30 observations. Combining observations to meet these requirements reduces the potential 125 profiles to 76.

Measuring Economic Achievability

For agricultural operations, there are several measures against which the costs of required management measures should be compared to show the degree to which they are economically achievable. First, *gross cash income* (the sum of livestock and crop sales, government payments, and other farm-related income) and *cash operating expenses* are measures of the economic size of the operation. They are used to show the costs of required management measures as a proportion of what the operation takes in or the total costs of doing business. These measures show the costs relative to the volume of business for the farm.

Second, *net farm income* is defined as gross cash income, less variable cash expenses such as seed, fertilizer, and hired labor, and less fixed costs for land, insurance, and property taxes, less depreciation charges and labor noncash benefits, plus the value of inventory change and nonmoney income. Net farm income is a measure of the net income from farming, a return to the owner's labor, management, and equity. The value of operator labor is not accounted for, and no charge is made for management or the owner's capital invested in the farm.

The above quantities are measures of the farm as a business unit that presumably responds to economic principles of profit and loss. However, 21 percent of farms profiled in table 6 sell less than \$10,000 in agricultural commodities and are part-time businesses, at best. Many of these farms may be motivated by noneconomic considerations and should be considered hobbies or recreational activities, rather than businesses, particularly when net farm income is negative. For the United States, 59 percent of farm operators reporting negative household farm income had nonfarm occupations. Over 90 percent had off-farm income averaging \$35,747 per year. Operators with negative farm income averaged 1,330 hours per year working on the farm. Forty-seven percent spent less than 1,000 hours

working on the farm (Ahearn, and others, 1993, pp. 117-18). Adding off-farm sources of income and income from other farm operations to net farm income yields a measure of the full money income available to the operation, called *Farm and Nonfarm Income*, that may provide a more appropriate comparison for the costs of required measures where the motivation for farming cannot clearly be ascribed to economics. Note that this is not equivalent to farm operator household income as measured by USDA because it includes all net farm income, including that going to households other than the principal operator's household (USDA, ERS, 1993). It is a measure of the total income available to meet environmental requirements.

When net farm income is negative even before management measure costs are considered, costs of required measures as percentages of net farm income are difficult to interpret. Negative farm incomes can occur over long periods for several reasons. On part-time farms, losses can be offset by off-farm income and can reduce total income tax liability while farm real estate assets are appreciating. On larger farms motivated by profit and loss, farmers may not fully account for noncash costs, such as the depreciation on machinery and buildings, that are true economic costs and are accounted for here. For some livestock operations, gross sales can be low and net farm income can be negative for a period of years if stock is held off the market to increase the herd size. Data used in this analysis are averages for groups of farms with similar characteristics. Operations with losses and gains, representing the range of abilities and resources, are combined in the average. Gross farm income, operating expenses, total farm and nonfarm income, or the magnitude of the annual cost of required measures should be considered in assessing economic achievability when initial net farm income is negative. Incomes and expenses for each farm profile and coefficients of variation are presented in appendix tables B1 through B10.

Results

In general, annual costs of the proposed measures are less than \$5,000 per farm for most farm sizes. Costs of installing measures range from 0 to 24 percent of gross cash income and 0 to 18 percent of cash operating expenses. As percentages of net farm income, costs have a wider range of from 0 to 62 percent, but initial net farm incomes are negative on 4 to 31 percent of farms profiled. Costs range from 0 to 24 percent of total farm and nonfarm income available to the operation. Detailed analyses of each management measure and their impact on the profiled farms' economic pic-

ture are presented next and summarized in the following section.

Erosion Management on Cultivated Cropland

This management measure requires the following:

"Apply the erosion component of a Conservation Management System (CMS) as defined in the Field Office Technical Guide of the USDA-SCS to minimize the delivery of sediment from agricultural lands to surface waters, or design and install a combination of management and physical practices to settle the settleable solids and associated pollutants in runoff delivered from the contributing area for storms of up to and including a 10-year, 24-hour frequency." (U.S. EPA, 1993, p. 2-12)

Economic impacts of these requirements were proxied by requiring practices that achieved the minimum erosion rate of either the tolerable soil loss level (T) or that which could be achieved by conservation tillage on all cultivated cropland in the coastal zone counties. Cost estimates for achieving this level of erosion control were modeled by analysts with the Texas Agricultural Experiment Station (TAES) and USDA's SCS, and the results applied to our farm profiles (TAES/SCS, 1992).

The TAES/SCS analysis assumes that 100 percent of farm program participants will adopt CMS practices because of USDA conservation compliance provisions for highly erodible land, thus meeting the requirements of the erosion management measure. This assumption, combined with trends in conservation tillage adoption, means that 85 percent of coastal zone cropland will use conservation tillage by 1995, up from about one-third of crop acreage currently. No new costs are associated with implementing the erosion management measure for this acreage under CZARA because the costs are incurred through voluntary adoption or must be incurred under USDA conservation compliance provisions.

The national modeling system used in the TAES/SCS analysis includes only 12 major crops, primarily field crops covered by USDA farm programs (table 7). Another 8.1 million acres of crops not modeled generally have lower current erosion rates than the modeled acreage, with 87 percent of such land eroding below tolerable (T) soil loss limits. About 1 million acres of crops not modeled are currently eroding above T, probably requiring additional erosion control treatment. Most (773,000 acres) of this crop acreage is in row crops for which practices could be devised (such as winter cover crops) to increase soil cover and reduce erosion, while the remaining 285,000 acres is in orchard and closegrown crops (such as, flax and small

grains) for which soil conservation practices are probably not practical. Costs of reducing erosion on crops not modeled are not included in the TAES/SCS analysis, but we included them by assuming that the cost of treating erosion on crops not modeled is similar to the cost on crops that are modeled.

The cropland base modeled in the TAES/SCS analysis is divided into four cropland classes:

- Wet soils—Cropland in USDA land capability classes III-VIII with subclass w, generally limited for crop production because of wetness;
- Low erodibility—Cropland with an erodibility index ($EI = RKLS/T$ of the universal soil loss equation) less than 8.
- Moderate erodibility—Cropland with an erodibility index between 8 and 20.
- High erodibility—Cropland with an erodibility index greater than 20.

In general, the higher the erodibility index, the higher the costs of achieving a given erosion reduction. Relatively little high erodibility land is cropped in most coastal regions. Only 830,000 acres of cropland modeled in the coastal zone are highly erodible. This amounts to 2.7 percent of coastal zone cropland, compared with nearly a third of cropland in the United States as a whole.

The mix of cropland classes on a particular farm is the key determinant of the economic achievability of the erosion control management measure. Results are presented by region, assuming that the farm profiles representing typical farms have the same distribution of cropland by erodibility class as for the region as a whole. Because high erodibility land is a small proportion of total cropland in each region, the average costs of changing to CMS practices are small. However, costs for a farm that has a higher-than-average proportion of high erodibility land will be greater than average. For this reason, costs per acre and percentage changes in income are presented for each cropland class in appendix A.

Costs of switching to CMS practices include decreases in land that can be farmed, substitution of crops with lower profits, and changes in production methods that increase costs. However, to the extent that these changes reduce operating costs, such as from reduced labor or machinery costs for conservation tillage, farm income may actually increase. The total impact does not fall proportionately on all farmers; operators of

Table 7—Cropland by gross soil erosion in relation to tolerance level, by coastal region, 1987

Coastal region	Status	Eroding at rate			Share eroding at rate	
		≤T	>T	Total	≤T	>T
		-----Thousand acres-----			-----Percent of total-----	
Great Lakes	Modeled ¹	12,286	2,532	14,818	82.9	17.1
Gulf	Modeled	7,111	1,662	8,773	81.1	18.9
Northeast	Modeled	4,927	1,350	6,277	78.5	21.5
Southeast	Modeled	6,662	1,842	8,504	78.3	21.7
West	Modeled	2,086	284	2,370	88.0	12.0
Total	Modeled	33,072	7,670	40,742	81.2	18.8
Great Lakes	Not modeled ^{2,3,4}	903	67	969	93.1	6.9
Gulf	Not modeled	1,037	179	1,216	85.3	14.7
Northeast	Not modeled	596	275	871	68.4	31.6
Southeast	Not modeled	2,943	361	3,304	89.1	10.9
West	Not modeled	1,604	176	1,780	90.1	9.9
Total	Not modeled	7,083	1,057	8,140	87.0	13.0
		Eroding at rate			Share eroding at rate	
	Crop type	≤T	>T	Total	≤T	>T
Total	Orchard/bush/berry ²	2,679	184	2,863	93.6	6.4
Total	Closegrown ³	937	101	1,038	90.2	9.8
Total	Row crops ⁴	3,467	773	4,240	81.8	18.2
Total	Other horticultural	225	28	253	88.8	11.2
Total	Peanuts	308	152	460	67.0	33.0
Total	Potatoes	135	56	191	70.5	29.5
Total	Other row crops	1,174	52	1,225	95.8	4.2
Total	Sunflowers	32	1	33	97.3	2.7
Total	Tobacco	262	195	456	57.4	42.6
Total	Other vegetables	1,332	289	1,620	82.2	17.8
		Eroding at rate			Share eroding at rate	
	Status	≤T	>T	Total	≤T	>T
Total	Not modeled	7,083	1,057	8,140	87.0	13.0

¹Includes corn, silage, sorghum, soybeans, cotton, wheat, oats, rice, barley, hay, sugar beets, and sugarcane crops.

²Includes fruit, nut, vineyard, bush fruit, and berry crops.

³Includes all other closegrown crops not listed under ¹.

⁴Includes peanuts, potatoes, tobacco, sunflowers, other horticultural, other vegetable, and all other row crops not listed under ¹.

Source: 1987 National Resources Inventory, USDA.

the most erodible land bear the brunt of the adjustments and have the greatest reduction in erosion rates. Farmers are generally assumed to minimize their costs of production and would presumably have adopted conservation tillage if it were less costly than alternative methods. In theory, farmers who can derive economic benefits from adopting conservation tillage should have already done so, leaving no potential cost savings. Lags in the diffusion of conservation tillage

technology, depreciation and investment costs of changing to conservation tillage equipment, and adherence to traditional farming methods are reasons advanced to account for potential cost savings from adopting conservation methods.

Average costs across all erodibility classes range from a high of \$3,480 for large farms in the Northeast to an increase in returns of \$1,369 for large farms in the

Southeast (table 8). Costs are less than 5 percent of net farm income on 77 percent of farms profiled. Because of negative initial net farm income, costs cannot be expressed as a percent for 23 percent of farms profiled, most of which are farms selling less than \$10,000 annually. Average costs are less than 1 percent of total farm and nonfarm income on 86 percent of farms profiled.

Costs for high erodibility cropland are higher than the average cost for all coastal regions and farms profiled (table 9). Especially impacted are medium-sized farms in the Gulf Coast region (34-46 percent of net farm income and 12-22 percent of total farm and nonfarm income) and small- and medium-sized farms in the Great Lakes region (25-48 percent of net farm income and 8-15 percent of total farm and nonfarm income). The economic impact of erosion management on farms with greater than average amounts of high erodibility cropland will be greater than the average impact, but there is no data to determine the amount of cropland with differing erodibility for farms in each economic class.

Nutrient and Pesticide Management

This measure consists of securing information services, such as soil testing, nutrient recommendations, and integrated pest management scouting services, necessary to reduce nutrient and pesticide applications. Specifically, for nutrient management, farmers are required to:

"Develop, implement, and periodically update a nutrient management plan to:

- (1) Apply nutrients at rates necessary to achieve realistic crop yields,*
- (2) Improve the timing of nutrient application, and*
- (3) Use agronomic crop production technology to increase nutrient use efficiency.*

When the source of the nutrients is other than commercial fertilizer, determine the nutrient value and the rate of availability. Determine and credit the nitrogen contribution of any legume crop. Soil and plant tissue testing should be used routinely." (U.S. EPA, 1993, p. 2-52)

For pesticide management, farmers are required:

"To reduce contamination of surface water and ground water from pesticides:

- (1) Evaluate the pest problems, previous pest control measures, and cropping history;*

(2) Evaluate the soil and physical characteristics of the site, including mixing, loading, and storage areas for potential leaching or runoff of pesticides. If leaching or runoff is found to occur, steps should be taken to prevent further contamination;

(3) Use integrated pest management (IPM) strategies that:

(a) Apply pesticides only when an economic benefit to the producer will be achieved (i.e., applications based on economic thresholds); and

(b) Apply pesticides efficiently and at times when runoff losses are unlikely;

(4) When pesticide applications are necessary and a choice of registered materials exists, consider the persistence, toxicity, runoff potential, and leaching potential of products in making a selection;

(5) Periodically calibrate pesticide spray equipment; and

(6) Use anti-backflow devices on hoses used for filling tank mixtures." (U.S. EPA, 1993, p. 2-61)

Average annual costs, based on the ACP Integrated Crop Management program (SP53), are estimated to range from \$8.36 to \$11.48 per cultivated acre. Assuming a conservatively small 10 percent decrease in agricultural chemical costs from utilizing better management information, the resulting average total costs are estimated to range from a net gain of \$151 per farm to a net loss of up to \$4,055 (table 10). No cost-sharing is assumed, despite the current 75 percent cost-share being paid on SP53 and potential cost-sharing under USDA's Water Quality Incentives Program (WQIP), because these are incentive programs that will not continue once farm operators become familiar with the information services.

These net costs result in reductions in gross cash income ranging from 0 percent to 8 percent and increases in operating expenses of 0 percent to 4 percent. Gross incomes decline less than 1 percent on 55 percent of farms profiled, and operating expenses increase less than 1 percent on 40 percent of farms. Net farm incomes are reduced from 0 percent to 18 percent, with the largest reductions on smaller farms. Net farm incomes decline less than 5 percent on 45 percent of farms profiled, while initial net incomes are negative on 23 percent. Total farm and nonfarm income is reduced 0 percent to 7 percent, with 54 percent of profiled farms' incomes reduced less than 1 percent.

Table 8—Summary of economic availability of erosion control measures on average cultivated cropland, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Dollars</i>					
Northeast Coast					
Average cost	368	621	814	1,544	3,480
<i>Percent</i>					
Share of:					
Gross cash income ²	8	2	1	1	1
Cash operating expense ³	3	2	2	1	1
Net farm income ⁴	2	NA	5	4	2
Farm and nonfarm income ⁵	1	4	3	3	1
<i>Dollars</i>					
Southeast Coast					
Average cost	(66)	(161)	(308)	(592)	(1,369)
<i>Percent</i>					
Share of:					
Gross cash income	1	1	0	0	0
Cash operating expense	1	1	1	0	0
Net farm income	NA	7	1	1	1
Farm and nonfarm income	0	1	1	1	1
<i>Dollars</i>					
Gulf Coast					
Average cost	120	376	673	1,424	1,769
<i>Percent</i>					
Share of:					
Gross cash income	2	1	1	1	0
Cash operating expense	1	1	1	1	0
Net farm income	NA	NA	4	5	1
Farm and nonfarm income	0	2	1	3	1
<i>Dollars</i>					
Great Lakes					
Average cost	96	214	376	712	1,486
<i>Percent</i>					
Share of:					
Gross cash income	1	1	1	0	0
Cash operating expense	1	1	1	1	0
Net farm income	NA	4	2	2	1
Farm and nonfarm income	0	1	1	1	1
<i>Dollars</i>					
West Coast					
Average cost	-----8-----		17	35	68
<i>Percent</i>					
Share of:					
Gross cash income	-----0-----		1	0	0
Cash operating expense	-----0-----		1	1	0
Net farm income	-----0-----		4	1	1
Farm and nonfarm income	-----0-----		1	1	1

NA = Not appropriate; initial income was negative.

() = Increase or positive change in income.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Table 9—Summary of economic availability of erosion control measures on highly cultivated cropland, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Dollars</i>					
Northeast Coast					
Average cost	817	1,379	1,808	3,428	7,727
<i>Percent</i>					
Share of:					
Gross cash income ²	17	5	3	2	1
Cash operating expense ³	7	4	4	3	2
Net farm income ⁴	5	NA	10	9	4
Farm and nonfarm income ⁵	2	8	6	6	3
<i>Dollars</i>					
Southeast Coast					
Average cost	845	2,056	3,947	7,582	17,533
<i>Percent</i>					
Share of:					
Gross cash income	16	6	6	4	3
Cash operating expense	9	7	7	6	5
Net farm income	NA	90	16	15	15
Farm and nonfarm income	4	8	7	11	11
<i>Dollars</i>					
Gulf Coast					
Average cost	1,018	3,176	5,689	12,041	14,954
<i>Percent</i>					
Share of:					
Gross cash income	20	11	8	7	2
Cash operating expense	10	10	8	9	3
Net farm income	NA	NA	34	46	6
Farm and nonfarm income	3	15	12	22	6
<i>Dollars</i>					
Great Lakes					
Average cost	1,194	2,671	4,694	8,882	18,532
<i>Percent</i>					
Share of:					
Gross cash income	19	10	6	6	4
Cash operating expense	11	11	9	8	6
Net farm income	NA	48	25	22	19
Farm and nonfarm income	4	8	15	16	16
<i>Dollars</i>					
West Coast					
Average cost	-----201-----		408	866	1,660
<i>Percent</i>					
Share of:					
Gross cash income	-----1-----		7	5	2
Cash operating expense	-----1-----		8	8	3
Net farm income	-----7-----		49	16	9
Farm and nonfarm income	-----1-----		16	7	8

NA = Not appropriate; initial income was negative.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Table 10—Summary of economic availability and nutrient and pesticide management on average cultivated cropland, average cost and 10-percent reduction in chemical use, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Dollars</i>					
Northeast Coast					
Average cost	244	294	266	443	8
<i>Percent</i>					
Share of:					
Gross cash income ²	5	1	0	0	0
Cash operating expense ³	2	1	1	0	0
Net farm income ⁴	1	NA	2	1	0
Farm and nonfarm income ⁵	1	2	1	1	0
<i>Dollars</i>					
Southeast Coast					
Average cost	192	334	367	333	(151)
<i>Percent</i>					
Share of:					
Gross cash income	4	1	1	0	0
Cash operating expense	2	1	1	0	0
Net farm income	NA	15	1	1	0
Farm and nonfarm income	1	1	1	0	0
<i>Dollars</i>					
Gulf Coast					
Average cost	412	1,206	1,891	4,055	2,792
<i>Percent</i>					
Share of:					
Gross cash income	8	4	2	2	0
Cash operating expense	4	4	3	3	1
Net farm income	NA	NA	11	16	1
Farm and nonfarm income	1	6	4	7	1
<i>Dollars</i>					
Great Lakes					
Average cost	227	444	851	1,398	2,108
<i>Percent</i>					
Share of:					
Gross cash income	4	2	1	1	0
Cash operating expense	2	2	2	1	1
Net farm income	NA	8	5	3	2
Farm and nonfarm income	2	1	3	3	2
<i>Dollars</i>					
West Coast					
Average cost	-----512-----	-----	879	2,268	153
<i>Percent</i>					
Share of:					
Gross cash income	-----2-----	-----	1	1	0
Cash operating expense	-----2-----	-----	1	2	0
Net farm income	-----18-----	-----	9	4	0
Farm and nonfarm income	-----2-----	-----	3	2	0

NA = Not appropriate; initial income was negative.

() = Increase or positive change in income.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Chemical information service costs vary by region and crop more than indicated by the ACP integrated crop management costs. Fees quoted by private providers can include additional services such as soil fertility testing and recommendations, pesticide record keeping, field treatment records, and crop accounting services. Integrated pest management (IPM) scouting costs vary more between crops than between regions (table 11). For example, some private consultants provide scouting at a low cost which corresponds to a lower level of service. In the Great Lakes region, the low cost of \$4.95 per acre is based on five visits per season at the request of the producer. The higher cost service includes scouting and a weekly written report during the growing season. A number of factors tend to reduce the reliability of using scouting costs as a proxy for the cost of integrated crop management.

Private versus Public Management

Regional differences in crop management and scouting costs occur due to differences in funding and the source of the provider. In some States, the Cooperative Extension Service provides scouting services at no cost or for a nominal fee. An example is Maine's

Cooperative Extension Service, which regularly provides pest scouting and fertility recommendations. In other areas of the coastal zone, farmer cooperatives have formed crop management associations to provide scouting and crop fertility/pest management recommendations. Many of these associations charge a differential rate based on membership status. Crop management associations evolved to fill a niche not serviced by private consultants. For instance, associations have developed in parts of Pennsylvania where field sizes are small and crop production is dispersed. While Pennsylvania has a number of large private crop consulting companies, many of these firms did not service these sparse production areas.

Crop-Dependent

Widespread use of crop scouting services appears to be positively correlated with row crops covered under various farm programs. For example, pest scouting is more common on corn acres than on soybean acres in the Great Lakes. Likewise, scouting is more common on rice and cotton acres than on corn or soybean acres in the Gulf region. Commodity program benefits may justify additional costs of scouting services.

Table 11—Estimated scouting costs, by coastal region and crop, 1992

Coastal region	Corn	Soybeans	Wheat	Rice	Cotton	Fresh market vegetables ¹	Hay ²
<i>Dollars/acre</i>							
Northeast							
Low	5.50	NA	3.75	--	--	25.00	2.50
High	6.25	NA	4.50	--	--	28.00	2.75
Southeast							
Low	5.00	3.25	3.00	8.00	6.00	30.00	2.00
High	6.00	4.00	3.50	12.00	8.00	35.00	3.00
Gulf Coast							
Low	6.00	4.50	--	5.00	6.00	35.00	--
High	8.00	6.50	--	9.00	9.00	40.00	--
Great Lakes							
Low	4.95	4.25	3.75	--	--	--	4.75
High	5.50	5.00	4.00	--	--	--	5.25
West Coast							
Low	NA	NA	3.50	NA	6.75	32.00	NA
High	NA	NA	5.50	NA	9.30	38.00	NA

NA = Not applicable.

-- = Not available.

¹Most fresh market vegetables are produced under a regular spraying schedule.

²Scouting costs for hay are based on alfalfa insect inspection. The higher cost in the Great Lakes region includes pesticide and soil sampling.

However, use of scouting services is not strictly proportional to the value of the crop produced. High-value cash crops, such as fruits and vegetables, are usually produced under fixed spraying schedules because pest damage is permanent and may make the crop unmarketable. Relying on scouting to detect damage would not be timely or effective. Fruits and vegetables grown under contract are monitored and scouted by the canner's field staff, who recommend pesticide applications that are required by the contract.

Services from Agricultural Chemical Suppliers

Many large farmer cooperatives and agricultural chemical dealers provide crop management services, including scouting, free to customers who purchase major inputs (seed, fertilizer, pesticides) from their companies. This trend is likely to continue as added services substitute for cuts in input prices. Similarly, producers that do not purchase large quantities of inputs, or that shop around for lower input prices, may not receive free scouting services from dealers.

The management measure for nutrients provides information and planning that can result in potential fertilizer savings to increase profitability. A review of the literature suggests that these management measures can provide net reductions in costs, by reducing fertilizer purchases, while not affecting crop yield.

Economic benefits from nitrogen management assume that current efforts to improve calibration of nitrogen fertilizer recommendations will be well advanced by 1995. Fertilizer recommendations typically cost under a dollar per acre, so economic achievability hinges on whether cost savings can result without substantial yield reductions and increases in application costs. Literature studies document a 12-percent reduction in nitrogen use without yield loss in Iowa, a 40-percent reduction over 8 years in Pennsylvania from improved calibration and late spring soil testing, 12-30-pound per acre reductions in Nebraska, and 50-percent reductions in Vermont (Ogg, 1992; Iowa State University, 1991; Berry and Hargett, 1984; Magdoff and others, 1984). Soil testing for phosphorus (P) in North Carolina and Iowa shows many soils have high built-up P-levels which make additional phosphorus applications uneconomic (Novais and Kamprath, 1978; Killorn, 1990; Sims, 1992). Nutrient management plans on 114,300 acres in the Chesapeake Bay drainage reduced total nitrogen and phosphorus 31.5 and 37.5 pounds per acre, largely through better utilization of animal waste (U.S. EPA, 1991). Improved nutrient management in 16 demonstration projects and 74 hydrologic unit areas participating in USDA's water quality program resulted in reductions of 28-33

pounds per acre of nitrogen and 62 pounds per acre of phosphorus (USDA, 1992).

Our assumed 10-percent reduction in chemical costs is conservative. However, some agronomists argue that most fertilizer-use reductions that would leave yields unaffected have already been taken. This alternative view is not reflected in this analysis.

Irrigation Management

The irrigation management measure requires maximum water use efficiency of the irrigation system, consistent with requirements of local water law. Specifically:

"To reduce nonpoint source pollution of surface waters caused by irrigation:

(1) Operate the irrigation system so that the timing and amount of irrigation water applied match crop water needs. This will require, as a minimum: (a) the accurate measurement of soil-water depletion volume and the volume of irrigation water applied; and (b) uniform application of water.

(2) When chemigation is used, include backflow preventers for wells, minimize the harmful amounts of chemigated waters that discharge from the edge of the field, and control deep percolation. In cases where chemigation is performed with furrow irrigation systems, a tail-water management system may be needed."
(U.S. EPA, 1993, p. 2-88)

The measure recognizes a number of limitations and special conditions based on water law that may limit the extent to which the measure can actively be applied. EPA assumes that major components of the system would not be replaced to comply with the measure, with costs limited to components to manage the timing and amount of water applied. This includes flow meters, tensiometers, soil moisture probes, and labor and time for scheduling and irrigation improvement, estimated to cost \$10 per acre.

Due to limited sample numbers for irrigated farms, no farm profiles could be constructed for the Northeast region, two for all economic classes were constructed for the Southeast and Great Lakes coastal regions, three for the Gulf region, and four for the West Coast region (table 12). Average annualized regional irrigation management costs per farm range from \$151 for small farms on the West Coast to \$2,469 for larger farms.

Average annualized costs for the irrigation management measure are less than 1 percent of gross cash income for all farms and are less than 1 percent of

Table 12—Summary of economic achievability of irrigation management measures, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
Northeast Coast					
No farms profiled					
<i>Dollars</i>					
Southeast Coast					
Average cost	-----	279-----			834
<i>Percent</i>					
Share of:					
Gross cash income ²	-----	0-----			0
Cash operating expense ³	-----	0-----			0
Net farm income ⁴	-----	1-----			1
Farm and nonfarm income ⁵	-----	1-----			1
<i>Dollars</i>					
Gulf Coast					
Average cost	-----	371-----	1,002		1,216
<i>Percent</i>					
Share of:					
Gross cash income	-----	1-----	1		0
Cash operating expense	-----	1-----	1		0
Net farm income	-----	NA-----	3		1
Farm and nonfarm income	-----	1-----	2		1
<i>Dollars</i>					
Great Lakes					
Average cost	-----	349-----			1,074
<i>Percent</i>					
Share of:					
Gross cash income	-----	0-----			0
Cash operating expense	-----	0-----			0
Net farm income	-----	3-----			1
Farm and nonfarm income	-----	1-----			1
<i>Dollars</i>					
West Coast					
Average cost	-----	151-----	261	2,469	1,316
<i>Percent</i>					
Share of:					
Gross cash income	-----	1-----	0	1	0
Cash operating expense	-----	1-----	0	2	0
Net farm income	-----	10-----	3	6	1
Farm and nonfarm income	-----	0-----	0	2	1

NA = Not appropriate; initial income was negative.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

cash operating expense on 86 percent of farms profiled. As a percent of net farm income, costs are less than 1 percent on 35 percent of profiled farms and less than 5 percent on 58 percent of profiled farms. Six percent of farms have negative initial net incomes.

Grazing Management

The grazing management measure calls for protecting riparian areas and implementing a grazing management plan. Specifically to:

“Protect range, pasture and other grazing lands:

(1) By implementing one or more of the following to protect sensitive areas (such as streambanks, wetlands, estuaries, ponds, lake shores, and riparian zones):

(a) Exclude livestock,

(b) Provide stream crossings or hardened watering access for drinking,

(c) Provide alternative drinking water locations,

(d) Locate salt and additional shade, if needed away from sensitive areas, or

(e) Use improved grazing management (e.g., herding) to reduce the physical disturbance and reduce direct loading of animal waste and sediment caused by livestock; and

(2) By achieving either of the following on all range, pasture, and other grazing lands not addressed under (1):

(a) Implement the range and pasture components of a Conservation Management System (CMS) as defined in the Field Office Technical Guide of the USDA-SCS.

(b) Maintain range, pasture, and other grazing lands in accordance with activity plans established either by the Bureau of Land Management of the U.S. Department of the Interior or the Forest Service of USDA.” (U.S. EPA, 1993, p. 2-73)

Grazing management measure costs for riparian areas are \$14.22 per acre for stream protection and \$160 per acre for streambank stabilization. These costs per acre treated, when applied to the varying percentages of acres needing treatment in the riparian zones in each region and the acres of grazing land in each farm profile, result in costs ranging from \$12 to \$75,539 per farm, including cost-sharing (table 13).

The costs range from 0 to 12 percent of gross cash income and cash operating expenses. Costs as a percentage of gross cash income and operating expenses were less than 1 percent on 92 percent of farms profiled. Net farm income was reduced by 0 to 58 percent with 62 percent of profiled farms losing less than 5 percent of net farm income. For 31 percent of farms profiled, average net farm income in 1989 was negative, rendering any comparison with net income meaningless. As a percentage of total farm and non-farm income, grazing management costs ranged from 0 to 2 percent, with costs for 92 percent of farms profiled amounting to less than 1 percent of total farm and nonfarm income. Total farm and nonfarm income, before applying grazing management practices, was negative for 1 percent of farms profiled.

Grazing management costs are highest in the West Coast region, ranging from 2 to 10 percent of gross cash income, 6 to 58 percent of net farm income, and 2 percent of total farm and nonfarm income. Smaller farms (less than \$100,000 in sales) suffer the greatest percentage losses in net farm income, but total farm and nonfarm income losses are 2 percent. West Coast farms are affected to a greater extent than elsewhere because the proportion of grazing land adequately protected is smaller than in other regions and the acreage of grazing land is larger.

Combined Dairy and Swine Operation Analyses

Many farm operations will need to comply with several management measures covering different parts of their farm. Most dairy operations will need to comply with confined animal facility measures, including storing and land application of runoff and animal waste from barnyards, erosion management on cropland used to grow feed for dairy cattle, and grazing management on pasture used by dairy cattle during part of the year. Swine operations will need to comply with effluent runoff and erosion management requirements. Total costs for complying with combined measures are higher than for each measure considered independently.

Management measures for facility wastewater and runoff from large and small confined animal facilities specify the following:

For large units:

“Limit the discharge from the confined animal facility to surface waters by:

(1) Storing both the facility wastewater and the runoff from confined animal facilities that is caused by storms up to and including a 25-year,

Table 13—Summary of economic achievability of grazing management measures, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Dollars</i>					
Northeast Coast					
Total cost (including cost-share) -----			68-		
<i>Percent</i>					
Share of:					
Gross cash income ² -----			0-		
Cash operating expense ³ -----			0-		
Net farm income ⁴ -----			NA-		
Farm and nonfarm income ⁵ -----			0-		
<i>Dollars</i>					
Southeast Coast					
Total cost (including cost-share)	23	58	-----	105-	
<i>Percent</i>					
Share of:					
Gross cash income	0	0	-----	0-	
Cash operating expense	0	0	-----	0-	
Net farm income	3	1	-----	0-	
Farm and nonfarm income	0	0	-----	0-	
<i>Dollars</i>					
Gulf Coast					
Total cost (including cost-share)	23	44	489	276	1,237
<i>Percent</i>					
Share of:					
Gross cash income	1	0	1	0	0
Cash operating expense	0	0	1	0	0
Net farm income	3	NA	4	2	2
Farm and nonfarm income	0	0	1	1	1
<i>Dollars</i>					
Great Lakes					
Total cost (including cost-share)	12	29	23	-----	39-
<i>Percent</i>					
Share of:					
Gross cash income	0	0	0	-----	0-
Cash operating expense	0	0	0	-----	0-
Net farm income	NA	0	0	-----	0-
Farm and nonfarm income	0	0	0	-----	0-
<i>Dollars</i>					
West Coast					
Total cost (including cost-share) -----		656-		4,672	75,539
<i>Percent</i>					
Share of:					
Gross cash income -----		2-		3	10
Cash operating expense -----		2-		4	12
Net farm income -----		58-		6	NA
Farm and nonfarm income -----		2-		2	NA

NA = Not appropriate; initial income was negative.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

24-hour frequency storm. Storage structures should:

(a) Have an earthen lining or plastic membrane lining, or

(b) Be constructed with concrete, or

(c) Be a storage tank; and

(2) Managing stored runoff and accumulated solids from the facility through an appropriate waste utilization system." (U.S. EPA, 1993, p. 2-33)

For small units:

"Design and implement systems that collect solids, reduce contaminant concentrations, and reduce runoff to minimize the discharge of contaminants in both facility wastewater and in runoff that is caused by storms up to and including a 25-year, 24-hour frequency storm. Implement these systems to substantially reduce significant increases in pollutant loadings to ground water. Manage stored runoff and accumulated solids from the facility through an appropriate waste utilization system." (U.S. EPA, 1993, p. 2-43)

Requirements for small units are less stringent and apply to dairy operations of 20-69 head and swine operations of 100-199 head. Large-unit requirements are more stringent and pertain to dairies over 70 head and swine operations over 200 head. Small- and large-unit requirements also apply to beef feedlots, horse stables, and poultry operations of varying sizes.

Dairy Operations

Total annualized costs of the confined animal facility, erosion, and grazing measures range from \$717 per farm for small operations on the West Coast to \$26,824 for large dairies on the West Coast (table 14). Effluent runoff management costs are greater than 90 percent of total costs for the combined dairy operations. As a percentage of gross cash income, total costs for all measures range from 2 percent to 24 percent, with the highest percentages for smaller operations. Costs are less than 5 percent of gross cash income on 38 percent of profiled farms. Costs range from 3 percent to 18 percent of cash operating expenses, but are less than 10 percent for 80 percent of profiled farms. Costs are 0 to 62 percent of net farm incomes, but 0 to 24 percent of total farm and nonfarm incomes. Costs are greater than 10 percent of net farm income on 93 percent of profiled farms, but are greater than 10 percent of total farm and nonfarm income on only 48 percent of farms. Impacts on net farm income are greater for smaller operations, but impacts on total farm and nonfarm income are

greatest for medium-sized operations with little off-farm income to offset costs.

Swine Operations

Total annualized costs of the confined animal facility and erosion measures range from \$397 per farm for small operations to \$3,586 for large swine operations in the Great Lakes (table 15). While total costs are not as great as for dairy operations, effluent runoff management costs on swine farms are also a large proportion of total costs. These costs are always less than 2 percent of gross cash income and of cash operating expenses. Costs are 1 percent to 32 percent of net farm incomes, but 0 percent to 8 percent of total farm and nonfarm incomes. Costs are less than 5 percent of net farm income on 41 percent of farms profiled. Impacts on net farm income are greater for smaller operations and are largest in the Gulf Coast because of larger runoff volumes.

Summary and Conclusions

In general, annual costs of the proposed CZARA management measures are less than \$5,000 per farm for most farm sizes (table 16). Exceptions are grazing management measures on larger farm sizes in the West, for which costs range up to \$75,539, and combined measures on larger dairy farms in all regions, for which costs range from \$9,606 to \$26,824.

The soil erosion measure costs less than 1 percent of either gross income or operating expenses for over 90 percent of profiled farms. Costs are less than 1 percent of total farm and nonfarm income on 86 percent of farms (table 17). Costs of erosion control on program crops may be high, but will not be attributable to this program because much of the cost on highly erodible land will be incurred to meet requirements under USDA's Conservation Compliance Program. While costs are small for the average mix of erodible and less erodible land, they could be significant for farms with large acreages of highly erodible cropland that cannot be adequately treated with conservation tillage and other low-cost practices. For 23 percent of farms affected by the erosion control measure, initial net farm income is negative before the management measure is applied. The additional costs of implementing the erosion management measure under CZARA will further aggravate these farms' financial situation.

The costs of acquiring soil tests, nutrient recommendations, and pest management information for nutrient and pesticide management are relatively inexpensive. Costs for about half the farms are less

Table 14—Summary of economic achievability for combined dairy management measures, options 1 and 2, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Dollars</i>					
Northeast Coast					
Total cost (including cost-share) - - - - -	-972-		1,464	4,101	9,606
<i>Percent</i>					
Share of:					
Gross cash income ² - - - - -	5-		2	3	2
Cash operating expenses ³ - - - - -	3-		3	3	3
Net farm income ⁴ - - - - -	16-		7	10	9
Farm and nonfarm income ⁵ - - - - -	3-		5	7	8
<i>Dollars</i>					
Southeast Coast					
Total cost (including cost-share)	843	3,886	- - - - - 6,443-		12,032
<i>Percent</i>					
Share of:					
Gross cash income	17	11	- - - - - 6-		2
Cash operating expenses	11	14	- - - - - 8-		3
Net farm income	22	45	- - - - - 18-		15
Farm and nonfarm income	3	14	- - - - - 10-		12
<i>Dollars</i>					
Gulf Coast					
Total cost (including cost-share)	1,003	4,544	- - - - - 10,269-		718
<i>Percent</i>					
Share of:					
Gross cash income	24	21	- - - - - 9-		0
Cash operating expenses	16	18	- - - - - 10-		0
Net farm income	55	45	- - - - - 62-		0
Farm and nonfarm income	2	10	- - - - - 24-		0
<i>Dollars</i>					
Great Lakes					
Total cost (including cost-share) - - - - -	-942-		4,822	8,445	18,763
<i>Percent</i>					
Share of:					
Gross cash income - - - - -	4-		6	6	4
Cash operating expenses - - - - -	4-		8	8	5
Net farm income - - - - -	29-		25	19	20
Farm and nonfarm income - - - - -	4-		17	16	17
<i>Dollars</i>					
West Coast					
Total cost (including cost-share) - - - - -	-717-		- - - - - 8,277-		26,824
<i>Percent</i>					
Share of:					
Gross cash income - - - - -	7-		- - - - - 7-		2
Cash operating expenses - - - - -	5-		- - - - - 8-		3
Net farm income - - - - -	NA-		- - - - - 48-		17
Farm and nonfarm income - - - - -	3-		- - - - - 18-		15

Option 1 requires lined retention ponds and effluent irrigation.

Option 2 requires grassed infiltration areas.

NA = Not appropriate; initial income was negative.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Table 15—Summary of economic achievability for combined swine management measures, options 1 and 2, by coastal region, 1989

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
Northeast Coast					
No farms profiled					
<i>Dollars</i>					
Total cost (including cost-share)	-581-			1,655-	
<i>Percent</i>					
Share of:					
Gross cash income ²	1-			-1-	
Cash operating expenses ³	2-			-1-	
Net farm income ⁴	NA-			-3-	
Farm and nonfarm income ⁵	-3-			-2-	
<i>Dollars</i>					
Gulf Coast					
Total cost (including cost-share)	-1,893-				
<i>Percent</i>					
Share of:					
Gross cash income	2-				
Cash operating expenses	2-				
Net farm income	32-				
Farm and nonfarm income	8-				
<i>Dollars</i>					
Great Lakes					
Total cost (including cost-share)	397-	848	1,542	3,586	
<i>Percent</i>					
Share of:					
Gross cash income	2-	1	1	1	
Cash operating expenses	1-	1	1	1	
Net farm income	25-	8	5	4	
Farm and nonfarm income	2-	3	4	4	
West Coast					
No farms profiles					

Option 1 requires lined retention ponds and effluent irrigation.

Option 2 requires grassed infiltration areas.

NA = Not appropriate; initial income was negative.

¹Sales of crops and livestock products.

²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income.

³Cash operating expenses include all variable and fixed cash expenses.

⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income.

⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

than 1 percent of gross income, operating expenses, and total farm and nonfarm income and are less than 5 percent for 80-100 percent of farms affected. Costs are less than 5 percent of net farm income for 45 percent of farms affected. However, 23 percent of farms affected by this measure have negative initial net farm income. Nutrient and pesticide information costs are small, and even conservatively small (10 percent) esti-

mates of offsetting reductions in agricultural chemical costs through better management of these materials imply significantly reduced net costs. However, other changes to the farm operation, such as the method, timing, and cost of alternative nutrient and pesticide applications suggested by this information, could also increase farm costs in ways not accounted for in this

Table 16—Summary of economic achievability analyses for agricultural management measures, by coastal region

Item	Erosion management	Irrigation management	Grazing management	Nutrient and pesticide management	Combined dairy management	Combined swine management
<i>Number</i>						
Northeast Coast Farms	35,453	NA	8,789	35,453	25,130	NA
<i>Dollars</i>						
Average annual cost	368-3,480	NA	68	8-443	972-9,606	NA
<i>Percent</i>						
Share of:						
Gross cash income	1-8	NA	0	0-5	2-5	NA
Cash operating expenses	1-3	NA	0	0-2	3	NA
Net farm income	NEG-5	NA	NEG	NEG-2	9-16	NA
Farm and nonfarm income	1-4	NA	0	0-2	3-8	NA
<i>Number</i>						
Southeast Coast Farms	50,826	5,438	34,578	50,826	23,386	6,485
<i>Dollars</i>						
Average annual cost	(66-1,369)	279-834	23-105	(151)-367	843-12,032	581-1,655
<i>Percent</i>						
Share of:						
Gross cash income	(0-1)	0	0	0-4	2-17	1
Cash operating expenses	(0-1)	0	0	0-2	3-14	1-2
Net farm income	(NEG-7)	1	0-3	NEG-15	15-45	NEG-3
Farm and nonfarm income	(0-1)	1	0	0-1	3-14	2-3
<i>Number</i>						
Gulf Coast Farms	78,304	13,678	136,329	78,304	30,874	4,459
<i>Dollars</i>						
Average annual cost	120-1,769	371-1,216	23-1,237	412-4,055	1,003-10,269	1,893
<i>Percent</i>						
Share of:						
Gross cash income	0-2	0	0-1	0-8	0-24	2
Cash operating expenses	0-1	0	0-1	1-4	0-18	2
Net farm income	NEG-5	NEG-3	2-4	NEG-16	0-62	32
Farm and nonfarm income	0-3	1	0-1	1-7	0-24	8
<i>Number</i>						
Great Lakes Farms	280,764	6,611	50,563	280,764	111,958	37,374
<i>Dollars</i>						
Average annual cost	96-1,486	349-1,074	12-39	227-2,108	942-18,763	397-3,586
<i>Percent</i>						
Share of:						
Gross cash income	0-1	0	0	0-4	4-6	1-2
Cash operating expenses	0-1	0	0	1-2	4-8	1
Net farm income	NEG-4	1-3	0	NEG-8	19-29	4-25
Farm and nonfarm income	0-1	1	0	1-3	4-17	2-4
<i>Number</i>						
West Coast Farms	34,839	44,484	20,487	34,839	15,724	NA
<i>Dollars</i>						
Average annual cost	8-68	151-2,469	656-75,539	153-2,268	717-26,824	NA
<i>Percent</i>						
Share of:						
Gross cash income	0-1	0-1	2-10	0-2	2-7	NA
Cash operating expenses	0-1	0-2	2-12	0-2	3-8	NA
Net farm income	1-4	1-10	NEG-58	0-18	NEG-48	NA
Farm and nonfarm income	0-1	0-2	NEG-2	0-3	3-18	NA

() = Increase or positive change in income.

NA = Data not available.

NEG = Base income is negative.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Table 17—Summary of economic achievability analyses for agricultural management measures

Measure	Cost as percent reduction in income measure						Total
	<1%	1-5%	5-10%	10-20%	>20%	Negative ¹	
	<i>Percent of farms with measure</i>						
Soil erosion management:							
Gross cash income	93	6	2	--	--	--	100
Cash operating expenses	94	6	--	--	--	--	100
Net farm income	20	57	--	--	--	23	100
Farm and nonfarm income	86	14	--	--	--	--	100
Nutrient and pesticide measurement:							
Gross cash income	55	41	3	--	--	--	100
Cash operating expenses	40	60	--	--	--	--	100
Net farm income	13	32	22	11	--	23	100
Farm and nonfarm income	54	38	8	--	--	--	100
Grazing management:							
Gross cash income	92	7	1	--	--	--	100
Cash operating expenses	92	7	1	--	--	--	100
Net farm income	23	39	1	--	6	31	100
Farm and nonfarm income	92	7	--	--	--	1	100
Irrigation management:							
Gross cash income	100	--	--	--	--	--	100
Cash operating expenses	86	14	--	--	--	--	100
Net farm income	35	23	35	--	--	6	100
Farm and nonfarm income	80	20	--	--	--	--	100
Combined dairy waste, erosion, and grazing management:							
Gross cash income	1	37	42	8	11	--	100
Cash operating expenses	1	41	38	19	--	--	100
Net farm income	1	--	6	34	55	4	100
Farm and nonfarm income	1	42	9	46	2	--	100
Combined swine waste and erosion management:							
Gross cash income	69	31	--	--	--	--	100
Cash operating expenses	82	18	--	--	--	--	100
Net farm income	--	41	19	--	31	9	100
Farm and nonfarm income	--	91	9	--	--	--	100

-- = No measure.

¹Percent of farms for which initial income was negative.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

analysis. Changes in nutrient and pesticide applications were assumed to not lower crop yields.

Grazing management costs are small, with over 90 percent of farms affected having costs less than 1 percent of gross income, operating expenses, and total farm and nonfarm income. A quarter of farms have costs less than 1 percent of net farm income, and another 39 percent have costs less than 5 percent of net farm income. Focusing management on areas along streams (riparian areas) reduces costs because these areas are small relative to total grazing land and

because the costs of practices in these areas are relatively low.

Riparian zone grazing management measures depend on actual conditions on the site. Average annual costs are generally less than \$5,000 per farm, but operating margins for cattle grazing operations are low and many of the smaller farms are part-time operations. Impacts on net farm income are generally less than 4 percent, but are higher for some farms in the West Coast region. Even in these cases, however, costs are less than 2 percent of total farm and nonfarm income.

This analysis estimates that practices will be needed on a limited area of total grazing land and that no losses in forage production will be associated with installing the practices on these small areas.

Irrigation system management measures analyzed, including flow metering and soil moisture probes to improve the timing and amount of irrigation water applied, do not significantly reduce farm incomes. Over 80 percent of farms affected by the irrigation management measure have costs less than 1 percent of gross income, operating expenses, and total farm and nonfarm income. The largest costs will be incurred by medium-sized farms in the West Coast region, but are relatively minor compared with gross and net farm incomes and total farm and nonfarm income. This analysis assumes that there are no changes in crop yields associated with reduced water applications that could be indicated by the flow and moisture information. Also, no reductions in farm expenses from reduced water applications are assumed or estimated. About a third of farms affected have costs less than 1 percent of net farm income, and 58 percent of farms have costs less than 5 percent of net farm income.

Combinations of effluent control and other measures, required on most dairy and hog farms, increase costs and decrease economic achievability. The management measures for confined animal facilities specify two options: a more expensive level of control (option 1), requiring lined retention ponds and irrigation of effluent, and an alternative for smaller herd sizes (option 2) that substitutes an infiltration area to reduce costs. More than 40 percent of dairy farms that would be affected by effluent control, erosion control, and grazing management requirements are estimated to incur costs greater than 20 percent of net farm income. Effluent management costs are more than 90 percent of the total costs incurred by small farms. However, small farms still have herd sizes too large to qualify for the less expensive effluent controls in option 2. In addition, because many of these operations are part-time, the impact of required controls on total farm and nonfarm income is less severe than on net farm income. Combined requirements are expected to have

smaller costs for confined hog operations, with 70 percent of farms having costs less than 5 percent of net farm income.

Because there are no hard and fast guidelines for what is economically achievable, any appraisal of the overall achievability of CZARA management measures to control agricultural nonpoint sources of water pollution is subjective. Small absolute dollar costs for most farms and the relatively low percentages of gross cash income, operating expenses, and total farm and non-farm incomes are evidence that the CZARA measures are economically achievable for most profiled farms. On the other hand, relatively large percentage impacts on net farm income, particularly for small-sized farms may not be economically achievable.

It is important to remember that these results are based on EPA's interpretation of what practices will be required under the various management measures. Actual State implementation of CZARA programs will undoubtedly differ and could be more sensitive to differences between individual farm operations. Thus, severe impacts on individual farm economic situations could be avoided or mitigated wherever possible as the program is actually implemented. However, in cases where a farm is operating with little regard to environmental externalities, economic impacts from requiring these measures could be larger than stated here when the program is implemented.

While coastal zone agriculture is quite different in both physical and economic terms from noncoastal agriculture, the general level of costs, impact on incomes, and relative differences between types of farms and size classes provide insight for a more comprehensive national program of nonpoint source control measures. Commodity price impacts of these measures' effects on agricultural production in the coastal zone are likely to be small. However, the effects of nationwide nonpoint source program would probably be large enough to affect commodity supplies and prices, which must be taken into account in assessing the measures' overall economic impacts.

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Appendix A: Methods

Specific assumptions used in estimating the cost of each management measure discussed in the text are described in this appendix.

Cropland Erosion Management Costs

Percentage changes in net income by region and cropland class from the TAES/SCS analysis were applied to initial net income and divided by initial crop acreage, yielding dollar changes in net income per cropped acre (app. table A1). For coastal regions encompassing more than one farm production region, an acreage-weighted average of the change in net income per cropped acre was used. These were multiplied by the cropland acres in the respective coastal region farm profiles to give an estimated total change in net income for each farm profile. These are interpreted as the costs of erosion management but are really net changes in farm income that include direct changes in production costs and indirect changes in income caused by shifting to less profitable crops. Both positive and negative changes were divided by the farm profile net farm income and total household income to give a percentage change, except where the incomes were negative. Results are shown in the detailed tables for each of the four cropland classes and for the acreage-weighted average, but only the average and high erodibility results are shown in the summary table.

Nutrient and Pesticide Management Measure Costs

Based on 1990-91 ACP data for the integrated crop management practice (SP53), average total annualized costs per acre were calculated as acreage-weighted averages of summary data for coastal States (app. table A2). These per acre costs were applied to the acres of cultivated cropland to determine the annualized cost per farm. The low and high values from the coastal States are also listed in each region, which represent the range of costs that could be incurred. It is important to note that these costs reflect the cost of obtaining information services related to crop nutrient and pesticide management. Additional costs that might result from changes in the farm operation because of operators using this information were not included. Such costs could include greater expense for applying chemicals in spring, custom application of chemicals due to delays caused by weather, or other changes. No cost-sharing was assumed for these practices because ACP practice SP53 is a special practice with limited duration, not an established practice for which cost-sharing can be assumed in the future.

Information service costs should allow farm operators to reduce chemical application because nutrient applications will be better matched to plant needs; fertilizer applications will be reduced because of better information on nutrient availability in the soil, animal wastes, and green manure crops; and pesticide applications will be matched to economic pest thresholds. Based on a literature review, a conservative assumption of 10-percent savings in agricultural chemical expenses was applied, reducing total costs of the measure. Dividing by the four income measures gives relative achievability.

Irrigation Management Costs

The costs of soil-water measuring devices range from \$3-4 for gypsum blocks up to \$4,000-\$4,500 phenic cells, based on estimates from North Carolina (app. table A3). A cost of \$10 per irrigated acre was assumed to cover investments in flow meters, tensiometers, and soil moisture probes. This cost was annualized at 10-percent interest over a 5-year useful life and applied to all irrigated acres in the farm profile. No cost-sharing was assumed on these costs.

Based on discussions with Extension Service irrigation specialists in the Great Plains, backflow prevention devices for center pivot irrigation systems cost from \$300-\$416 per well, translating to costs of \$1.88-\$3.20 per acre. Based on data from California and Nebraska, tailwater recovery systems range from \$97-\$125 per acre.

Based on average program costs for collections of practices, irrigation water conservation systems (WC4) cost \$86 per acre served when installed for the primary purpose of water conservation and \$52 per acre served when installed for the primary purpose of water quality improvement. Water management systems for pollution control (SP35) cost \$26 per acre served when installed for the primary purpose of water quality improvement and \$19 per acre served for erosion control.

Grazing Land Management Costs

Percentages of grazing land rated as adequately protected for conservation needs were determined from State-level 1982 USDA NRI data. The proportion of total land area in perennial streams was also determined from the 1982 NRI and a 100-foot riparian zone calculated as follows:

$$R = S_{66} * 6.061 + S_{660} * .673$$

where R = Acres of riparian area in a 100-foot strip on either side of the stream;

Appendix table A1—Summary impacts of cropland erosion management measures, by farm production region¹

Farm production region	Cropland classes ³				
	Wet soils	Low erodibility	Moderate erodability	High erodability	Total
<i>Percent change in net income</i>					
	-7.3	-15.8	-10.8	-31.1	-13.9
Northeast	8.2	-2.7	-29.1	-69.9	-5.5
Lake States	-0.1	-0.1	-2.7	-9.8	-0.5
Corn Belt	-0.1	0.4	-6.2	-27.5	-1.1
Appalachian	10.5	7.2	-22.7	-89.3	6.3
Southeast	-0.3	-0.4	-43.0	-79.4	-3.7
Delta States	-0.9	-1.9	-6.8	-12.6	-3.9
Southern Plains	0.1	-0.1	-0.1	-2.4	-0.1
Pacific					
<i>Baseline net income, million dollars</i>					
Northeast	50.5	78.1	18.6	14.4	161.7
Lake States	12.0	297.4	30.8	4.1	344.2
Corn Belt	75.2	355.0	36.5	9.3	476.0
Appalachian	56.2	109.5	11.0	6.4	183.1
Southeast	26.0	171.7	4.7	1.3	203.7
Delta States	95.3	48.1	9.9	1.2	154.6
Southern Plains	18.3	30.3	33.7	2.3	84.6
Pacific	36.4	114.7	3.7	6.6	161.4
<i>Baseline cropland, thousand acres</i>					
Northeast	1,160.7	1,803.0	428.9	334.4	3,727.0
Lake States	263.2	7,026.7	659.0	87.7	8,036.6
Corn Belt	811.3	3,800.8	388.9	99.0	5,100.0
Appalachian	1,192.4	2,318.0	240.0	139.9	3,890.3
Southeast	532.9	3,011.5	94.3	19.2	3,657.9
Delta States	1,742.0	861.1	119.5	14.3	2,736.9
Southern Plains	382.7	800.8	959.9	66.3	2,209.7
Pacific	389.4	1,225.1	39.3	68.8	1,722.6
<i>Change in net income, dollars per cropped acre</i>					
Northeast	-3.18	-6.84	-4.68	-13.39	-6.03
Lake States	3.74	-1.14	-13.60	-32.68	-2.36
Corn Belt	-0.09	-0.09	-2.53	-9.21	-0.47
Appalachian	-0.05	0.19	-2.84	-12.58	-0.52
Southeast	5.12	4.11	-11.31	-60.46	3.51
Delta States	-0.16	-0.22	-35.62	-66.63	-2.09
Southern Plains	-0.43	-0.72	-2.39	-4.37	-1.49
Pacific	0.09	-0.09	-0.09	-2.30	-0.09

Source: TAES/SCS, 1992.

¹The cropland erosion management measure specified in EPA, 1993, page 2-12, is simulated by limiting erosion rates to the lower of either the soil loss tolerance level (T-value) or the erosion produced by conservation tillage.

²Includes regions containing coastal States.

³Wet soils (w3-8) include land capability classes III-VIII with subclass w; Low erodibility soils have erodibility index (EI=RKLS/T) less than 8; moderate erodibility soils have 8 <EI<20; and high erodibility soils have EI>20.

Appendix table A2—Summary impacts of integrated crop management costs, by farm coastal State, 1990-91¹

State and region	Year	Primary purpose	Acres	Cost share	Cost	Adjusted cost ²
			<i>Total</i>	<i>-----Dollars per acre-----</i>		
Illinois	1991	W	11,415	4.98	6.64	6.64
Indiana	1990	O	502	6.97	9.30	9.40
Indiana	1991	W	3,115	3.12	4.16	4.16
Indiana	1991	O	6,095	5.35	7.13	7.13
Michigan	1990	O	1,597	10.04	13.38	13.54
Michigan	1991	O	1,802	9.59	12.79	12.79
Michigan	1991	W	8,507	5.89	7.85	7.85
New York	1991	W	5,123	8.89	11.85	11.85
New York	1990	W	2,046	12.10	16.13	16.32
New York	1991	O	96	6.85	9.14	9.14
Ohio	1991	W	2,244	7.48	9.98	9.98
Ohio	1991	O	1,928	7.11	9.48	9.48
Ohio	1990	W	172	5.69	7.59	7.68
Pennsylvania	1991	W	2,188	5.50	7.33	7.33
Wisconsin	1991	W	9,272	5.84	7.79	7.79
Wisconsin	1991	O	1,057	3.20	4.26	4.26
Great Lakes			57,159	6.26	8.35	8.36
Florida	1991	W	2,354	6.99	9.32	9.32
Florida	1991	O	3,605	7.00	9.33	9.33
Mississippi	1991	O	8,417	7.00	9.33	9.33
Mississippi	1990	W	2,186	7.00	9.33	9.44
Mississippi	1991	W	5,774	6.85	9.13	9.13
Mississippi	1990	O	6,436	7.03	9.37	9.48
Gulf Coast			28,772	6.97	9.30	9.33
Connecticut	1991	W	1,866	7.29	9.73	9.73
Connecticut	1991	O	1,792	8.18	10.91	10.91
Connecticut	1990	O	226	6.94	9.25	9.36
Connecticut	1990	W	579	7.00	9.33	9.44
Delaware	1991	W	639	4.95	6.60	6.60
Maine	1990	W	559	11.21	14.94	15.12
Maine	1991	O	210	3.69	4.91	4.91
Maine	1991	W	4,970	9.11	2.15	2.15
Maryland	1991	W	8,924	4.85	6.47	6.47
Maryland	1990	W	4,671	4.96	6.61	6.69
Maryland	1991	O	1,028	4.68	6.25	6.25
Massachusetts	1991	W	2,191	9.48	12.65	12.65
Massachusetts	1990	W	260	5.07	6.76	6.84
New Jersey	1991	O	479	4.92	6.57	6.57
New Jersey	1991	W	1,248	5.43	7.24	7.24
New York	1991	W	5,123	8.89	11.85	11.85
New York	1991	O	96	6.85	9.14	9.14
New York	1990	W	2,046	12.10	16.13	16.32
Pennsylvania	1991	O	9,239	6.16	8.21	8.21
Pennsylvania	1991	W	2,188	5.50	7.33	7.33
Rhode Island	1991	W	237	13.41	17.87	17.87
Vermont	1990	W	816	7.14	9.52	9.63
Vermont	1991	W	654	4.85	6.47	6.47
Vermont	1991	O	333	4.61	6.15	6.15
West Virginia	1991	O	468	9.75	13.00	13.00
West Virginia	1991	W	1,106	8.44	11.25	11.25
Northeast			51,948	6.92	9.22	9.24
Florida	1991	O	3,605	7.00	9.33	9.33
Florida	1991	W	2,354	6.99	9.32	9.32
South Carolina	1990	W	1,214	12.34	16.46	16.65
South Carolina	1991	W	1,276	12.08	16.11	16.11
Virginia	1991	W	8,846	4.27	5.69	5.69
Southeast			17,295	6.35	8.47	8.48
Oregon	1991	W	9	14.22	18.96	18.96
Washington	1991	W	698	8.81	11.75	11.75
West			707	8.88	11.84	11.84

Purpose W = Water quality improvement.

Purpose O = Other.

¹ACP integrated crop management practice (ACP SP-53) costs extracted from USDA-ASCS (1990) and USDA-ASCS (1991).

²1990 costs adjusted to 1991 constant dollars using the ratio of the index of prices paid for production items in 1991 to 1990 (173/171).

S₆₆ = Acres of perennial streams less than 66 feet wide; and

S₆₆₀ = Acres of perennial streams between 66 and 660 feet wide;

The factors 6.061 (200/33) and .673 (200/297) convert stream acreage to acreage 100 feet on either side of the stream, assuming the average width is 33 and 297 feet for the stream widths of 66 and 66-660 feet, respectively.

Riparian grazing land needing practices was calculated by multiplying the acres of grazing land times 1

minus the percentage adequately treated and then times the proportion of total land in the riparian zone.

Based on 1989-91 ACP data, average total annualized costs per acre and average cost-share rates for the streambank stabilization (SP10) and stream protection (WP2) practices were calculated as acreage-weighted averages of summary data for coastal States (app. table A4). These practices include such items as limited fencing to exclude livestock, stock trails and walkways to harden crossings and route livestock, pipelines and tanks to provide alternative water sources, and plantings. The exact mix of practices is not recorded but is assumed to be representative of the kinds of practices used to improve resource conditions related to water quality on grazing lands. These per acre costs were applied to the acres of riparian grazing land needing treatment to determine the annualized cost per farm. The low and high values from the coastal States are also listed for each practice in each region, which are used to represent the range of costs that could be incurred.

Cost-shares were estimated for each practice as the minimum of the cost-share rate times the cost, or the value of the maximum \$3,500 payment per farm in each year, annualized at 10-percent interest for a 20-year useful life. It was assumed that the two riparian grazing practices would be installed in separate years

Appendix table A3—Cost of soil water measuring devices

Device	Approximate cost
Flow meters	\$35-300, depending on size
Tensiometers	\$35 plus, depending on size
Gypsum blocks	\$3-4, \$200-400 for meter
Neutron probe	\$4,000-4,500
Phene cell	\$4,000-4,500

Sources: Evans and others, 1991, and personal communication cited in U.S. EPA, 1993.

Appendix table A4—Summary of Agricultural Conservation Reserve Program (ACP) costs for grazing management practices, 1989 and 1990¹

Coastal region	Practice ²	Rate	Adjusted cost/acre treated ³		
			Average	Low	High
		Percent	Dollars		
Great Lakes	SP10	41	19.13	13.50	52.03
	WP2	67	31.78	16.09	165.37
Gulf Coast	WP2	56	58.44	38.14	72.84
Northeast	SP10	46	160.53	52.03	1,023.61
	WP2	61	72.75	31.08	1,543.97
West Coast	SP10	41	100.19	19.59	132.36
	WP2	49	14.22	7.53	190.51
Southeast	WP2	48	75.90	13.21	224.73

¹ Acreage-weighted average of 1989 and 1990 costs.

² Practice combinations can include the following individual practices, where required:

WP2: Stream protection—channel vegetation, fencing, field border, filter strip, pipeline, stock trails and walkways, streambank and shoreline protection, tree planting, and trough or tank.

SP10: Streambank stabilization—critical area plantings, livestock exclusion, mulching, streambank and shoreline protection, and tree planting.

³ Average annual cost, adjusted to 1990 constant dollars using ratio of index of prices paid for production items from 1989 to 1990 (171/165).

Source: USDA-ASCS, 1992.

Appendix table A5—Summary of facility wastewater and runoff control costs for confined dairy and swine operations, by coastal region and herd size

Cost and region	Management measure for small units		Management measure for large units				
			<i>Head</i>				
Dairy operations							
Herd size	35	110	35	110	180	285	540
			<i>Dollars/year</i>				
Total cost:							
Northeast	704	1,871	1,212	2,996	4,952	8,316	17,982
Southeast	1,130	2,960	2,075	5,179	7,606	11,458	23,022
Gulf Coast	1,223	3,250	2,208	5,442	7,939	11,599	23,039
Great Lakes	704	1,871	1,212	2,996	4,952	8,316	17,982
West Coast	777	2,093	1,485	3,704	5,950	9,032	18,735
			<i>Dollars/head/year</i>				
Cost per head:							
Northeast	20.11	17.01	34.63	27.24	27.51	29.18	33.30
Southeast	32.29	26.91	59.29	47.08	42.26	40.20	42.63
Gulf Coast	34.95	29.54	63.09	49.47	44.11	40.70	42.67
Great Lakes	20.11	17.01	34.63	27.24	27.51	29.18	33.30
West Coast	22.20	19.03	42.43	33.67	33.06	31.69	34.69
			<i>Head</i>				
Swine operations, concrete floor							
Herd size	140	300	140	300	650	1,000	2,000
			<i>Dollars/year</i>				
Total cost							
Northeast	237	431	335	602	1,115	1,671	3,792
Southeast	253	456	396	712	1,318	1,956	4,288
Gulf Coast	303	561	499	902	1,655	2,360	4,943
Great Lakes	235	428	327	587	1,089	1,635	3,729
West Coast	246	444	374	675	1,243	1,798	3,917
			<i>Dollars/head/year</i>				
Cost per head							
Northeast	1.69	1.44	2.39	2.01	1.72	1.67	1.90
Southeast	1.81	1.52	2.83	2.37	2.03	1.96	2.14
Gulf Coast	2.16	1.87	3.56	3.01	2.55	2.36	2.47
Great Lakes	1.68	1.43	2.33	1.96	1.68	1.64	1.86
West Coast	1.76	1.48	2.67	2.25	1.91	1.80	1.96
			<i>Head</i>				
Swine operations, open yard							
Herd size	140	300	140	300	650	1,000	2,000
			<i>Dollars/year</i>				
Total cost							
Northeast	355	658	545	1,245	2,309	3,386	7,119
Southeast	426	796	914	1,659	3,098	4,603	8,435
Gulf Coast	640	1,231	1,294	2,374	4,460	5,715	10,348
Great Lakes	347	643	494	1,192	2,210	3,221	6,954
West Coast	395	738	798	1,521	2,796	3,961	7,444
			<i>Dollars/head/year</i>				
Cost per head							
Northeast	2.53	2.19	3.89	4.15	3.55	3.39	3.56
Southeast	3.04	2.65	6.53	5.53	4.77	4.60	4.22
Gulf Coast	4.57	4.10	9.24	7.91	6.86	5.72	5.17
Great Lakes	2.48	2.14	3.53	3.97	3.40	3.22	3.48
West Coast	2.82	2.46	5.70	5.07	4.30	3.96	3.72

¹Costs by herd size and runoff volume adjusted averaged for runoff volumes in eac coastal region.

Source: DPRA, Incorporated, 1992.

so that each could benefit from the annual \$3,500 maximum. Dividing by the four income measures gives relative achievability.

Costs of Combined Management Measures for Dairy and Swine Farms

Costs of runoff diversion and storage and land application of animal wastes by type, size of operation, and runoff volume developed by DPRA, Incorporated, (adding back estimated cost-shares calculated by DPRA) were converted to cost factors per animal. Runoff volume distributions for States in each coastal region were used to calculate average regional total and per animal costs (app. table A5). Interpolations between herd sizes calculated by DPRA were used to match costs per head to the number of animals in the profiled farms. These were multiplied by the number of animals in the respective size classes in each coastal region farm profile to give an estimated annual cost for installing the measure. Costs for the small unit management measure were used where animal numbers were less than cutoff sizes established by EPA, and the higher costs of the large unit measure were used where animal numbers were above the cutoff, but less than the

1,000 animal unit cutoff for National Pollution Discharge Elimination System (NPDES) permits.

Erosion and grazing management costs were calculated as described in the sections above, except that the number of acres of crop and pastureland by which cost factors were multiplied are those associated with the confined animal farm profiles, rather than the cultivated cropland and grazing farm profiles used above. Total costs, listed as "Sum of annual costs" in the appendix tables, are the sum of annualized effluent runoff practices, erosion practices, and grazing practices.

Cost-shares were estimated for each practice as the minimum of the cost-share rate times the cost, or the value of the maximum \$3,500 payment per farm in each year, annualized at 10-percent interest for a 20-year useful life. It was assumed that the effluent runoff and grazing practices would be installed over 2 years so that each could benefit from the annual \$3,500 maximum. No cost-share was assumed for the erosion management measure since it would be absorbed by USDA conservation compliance requirements.

Appendix B: Income Measures and Coefficients of Variation

Appendix table B1—Farm numbers and income measures per grazing cattle farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Number</i>					
Northeast Coast: Farms	-----	-----	-8,789-	-----	-----
<i>Dollars</i>					
Gross cash income ²	-----	-----	34,889-	-----	-----
Cash operating expense ³	-----	-----	36,417-	-----	-----
Net farm income ⁴	-----	-----	(5,229)-	-----	-----
Farm and nonfarm income ⁵	-----	-----	15,905-	-----	-----
<i>Number</i>					
Southeast Coast: Farms	16,205	14,060	-----	-4,313-	-----
<i>Dollars</i>					
Gross cash income	4,729	23,036	-----	-153,607-	-----
Cash operating expense	6,677	26,241	-----	-157,592-	-----
Net farm income	824	8,186	-----	-40,970-	-----
Farm and nonfarm income	28,194	57,346	-----	-71,050-	-----
<i>Number</i>					
Gulf Coast: Farms	59,820	54,610	13,166	5,467	3,267
<i>Dollars</i>					
Gross cash income	4,574	24,945	74,859	157,498	608,610
Cash operating expense	8,991	26,139	71,126	139,887	508,804
Net farm income	831	(836)	12,279	11,335	66,106
Farm and nonfarm income	27,220	25,703	49,964	54,283	102,312
<i>Number</i>					
Great Lakes: Farms	11,847	22,548	9,500	-----	-6,668-
<i>Dollars</i>					
Gross cash income	6,130	23,904	74,686	-----	150,232-
Cash operating expense	9,537	21,978	58,446	-----	113,880-
Net farm income	(189)	8,716	9,780	-----	38,670-
Farm and nonfarm income	21,650	31,991	31,449	-----	53,610-
<i>Number</i>					
West Coast: Farms	-----	-15,331-	-----	3,405	1,751
<i>Dollars</i>					
Gross cash income	-----	-29,787-	-----	183,362	791,016
Cash operating expense	-----	-30,316-	-----	109,378	655,899
Net farm income	-----	-1,137-	-----	82,749	(95,343)
Farm and nonfarm income	-----	-34,417-	-----	244,674	(66,467)

() = Negative income.

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B2—Farm numbers and income measures per cultivated crop farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Number</i>					
Northeast Coast: Farms	7,465	10,639	8,316	6,252	2,783
<i>Dollars</i>					
Gross cash income ²	4,864	26,553	70,261	156,956	587,180
Cash operating expense ³	11,643	33,966	50,707	121,311	391,939
Net farm income ⁴	17,550	(5,970)	17,519	37,326	217,330
Farm and nonfarm income ⁵	37,127	17,311	28,395	52,844	262,152
<i>Number</i>					
Southeast Coast: Farms	12,608	17,430	7,807	7,280	5,701
<i>Dollars</i>					
Gross cash income	5,387	31,811	70,877	169,163	529,381
Cash operating expense	9,658	29,894	57,795	124,734	387,545
Net farm income	(2,030)	2,296	25,126	51,696	116,165
Farm and nonfarm income	19,319	25,467	55,663	69,038	166,943
<i>Number</i>					
Gulf Coast: Farms	16,609	30,670	12,198	9,823	9,004
<i>Dollars</i>					
Gross cash income	5,162	27,999	75,719	176,842	695,238
Cash operating expense	9,796	32,987	73,443	141,592	449,390
Net farm income	(2,643)	(1,821)	16,916	26,138	236,286
Farm and nonfarm income	29,422	21,336	47,267	55,397	260,724
<i>Number</i>					
Great Lakes: Farms	38,340	98,212	60,373	62,538	21,301
<i>Dollars</i>					
Gross cash income	6,393	26,024	72,226	147,971	438,726
Cash operating expense	10,694	24,470	54,079	109,697	328,349
Net farm income	(1,025)	5,585	18,472	40,075	100,078
Farm and nonfarm income	32,617	31,648	31,211	54,433	113,695
<i>Number</i>					
West Coast: Farms	----- 11,762 -----		5,960	8,182	8,935
<i>Dollars</i>					
Gross cash income	----- 29,974 -----		69,898	166,642	897,749
Cash operating expense	----- 28,062 -----		60,157	110,252	569,709
Net farm income	----- 2,856 -----		9,570	54,325	196,397
Farm and nonfarm income	----- 26,466 -----		29,716	131,251	221,868

() = Negative income.

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B3—Farm numbers and income measures per irrigated farm, by coastal region

Item	Economic class ¹			
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999 \$250,000 or more
Northeast Coast:				
No farms profiled				
<i>Number</i>				
Southeast Coast:				
Farms	-----	4,138	-----	1,300
<i>Dollars</i>				
Gross cash income ²	-----	3,406	-----	572,975
Cash operating expense ³	-----	65,793	-----	436,014
Net farm income ⁴	-----	24,583	-----	93,979
Farm and nonfarm income ⁵	-----	48,078	-----	111,558
<i>Number</i>				
Gulf Coast:				
Farms	-----	4,500	4,038	5,140
<i>Dollars</i>				
Gross cash income	-----	55,519	192,065	727,547
Cash operating expense	-----	68,015	151,542	514,092
Net farm income	-----	(9,985)	29,885	175,717
Farm and nonfarm income	-----	33,507	60,601	228,224
<i>Number</i>				
Great Lakes:				
Farms	-----	3,761	-----	2,849
<i>Dollars</i>				
Gross cash income	-----	90,988	-----	710,362
Cash operating expense	-----	79,538	-----	543,496
Net farm income	-----	12,851	-----	122,381
Farm and nonfarm income	-----	27,279	-----	135,234
<i>Number</i>				
West Coast:				
Farms	-----	14,764	8,532	9,716 11,472
<i>Dollars</i>				
Gross cash income	-----	26,950	70,231	178,406 886,409
Cash operating expense	-----	27,269	56,544	131,656 702,271
Net farm income	-----	1,500	9,131	42,814 155,467
Farm and nonfarm income	-----	30,519	71,365	106,159 184,090

() = Negative income.

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B4—Farm numbers and income measures per combined dairy farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Number</i>					
Northeast Coast:					
Farms	----- 13,012-----		5,493	4,657	1,968
<i>Dollars</i>					
Gross cash income ²	----- 18,722-----		69,998	153,353	389,298
Cash operating expense ³	----- 28,151-----		49,300	117,401	249,093
Net farm income ⁴	----- 6,256-----		21,926	43,039	104,319
Farm and nonfarm income ⁵	----- 29,967-----		32,100	57,323	116,566
<i>Number</i>					
Southeast Coast:					
Farms	11,356	5,234	----- 4,592-----		2,204
<i>Dollars</i>					
Gross cash income	4,960	34,080	----- 106,582-----		545,896
Cash operating expense	7,733	27,715	----- 83,890-----		447,588
Net farm income	3,824	8,678	----- 36,362-----		79,361
Farm and nonfarm income	25,157	27,539	----- 65,338-----		98,259
<i>Number</i>					
Gulf Coast:					
Farms	12,108	11,538	----- 4,697-----		2,530
<i>Dollars</i>					
Gross cash income	4,158	21,626	----- 120,178-----		1,155,314
Cash operating expense	6,147	25,372	----- 98,154-----		657,696
Net farm income	1,833	10,017	----- 16,582-----		448,956
Farm and nonfarm income	51,262	44,929	----- 42,470-----		531,728
<i>Number</i>					
Great Lakes:					
Farms	----- 35,003-----		31,315	35,439	10,200
<i>Dollars</i>					
Gross cash income	----- 22,837-----		76,154	151,405	446,784
Cash operating expense	----- 23,590-----		57,253	112,260	346,713
Net farm income	----- 3,246-----		19,567	43,308	95,628
Farm and nonfarm income	----- 23,072-----		29,137	53,954	108,406
<i>Number</i>					
West Coast:					
Farms	----- 9,092-----		----- 2,555-----		4,077
<i>Dollars</i>					
Gross cash income	----- 11,001-----		----- 122,483-----		1,221,685
Cash operating expense	----- 13,903-----		----- 102,731-----		1,037,274
Net farm income	----- (664)-----		----- 17,180-----		162,143
Farm and nonfarm income	----- 21,603-----		----- 45,487-----		183,880

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and nonfarm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B5—Farm numbers and income measures per combined swine farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
Northeast Coast: No farms profiled					
	<i>Number</i>				
Southeast Coast: Farms	-----	4,308	-----	2,177	-----
	<i>Dollars</i>				
Gross cash income ²	-----	40,398	-----	329,321	-----
Cash operating expense ³	-----	38,403	-----	256,261	-----
Net farm income ⁴	-----	(412)	-----	54,792	-----
Farm and nonfarm income ⁵	-----	18,582	-----	72,699	-----
	<i>Number</i>				
Gulf Coast: Farms	-----	4,459	-----		
	<i>Dollars</i>				
Gross cash income	-----	85,505	-----		
Cash operating expense	-----	82,066	-----		
Net farm income	-----	5,929	-----		
Farm and nonfarm income	-----	22,945	-----		
	<i>Number</i>				
Great Lakes: Farms	-----	10,736	9,162	11,622	5,854
	<i>Dollars</i>				
Gross cash income	-----	24,307	66,285	150,769	421,652
Cash operating expense	-----	26,560	61,199	117,106	333,065
Net farm income	-----	1,567	10,251	31,892	89,742
Farm and nonfarm income	-----	24,065	25,337	44,022	102,254
West Coast: No farms profiled					

() = Negative income.

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B6—Coefficients of variation for income measures per grazing cattle farm, by coastal region

	Economic class ¹				
Item	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Number</i>					
Northeast Coast:					
Sample size	-----49-----				
<i>Coefficient</i>					
Gross cash income ²	-----25.57-----				
Cash operating expense ³	-----23.26-----				
Net farm income ⁴	-----79.17-----				
Farm and nonfarm income ⁵	-----44.14-----				
<i>Number</i>					
Southeast Coast:					
Sample size	73	77	-----58-----		
<i>Coefficient</i>					
Gross cash income	9.10	8.14	-----22.16-----		
Cash operating expense	10.14	15.31	-----19.89-----		
Net farm income	103.22	94.76	-----90.79-----		
Farm and nonfarm income	11.02	47.23	-----52.44-----		
<i>Number</i>					
Gulf Coast:					
Sample size	165	211	70	135	120
<i>Coefficient</i>					
Gross cash income	6.90	8.49	4.76	4.15	15.22
Cash operating expense	9.13	8.62	10.51	5.05	18.20
Net farm income	228.91	373.22	136.68	73.61	52.09
Farm and nonfarm income	11.28	11.23	37.54	21.02	34.71
<i>Number</i>					
Great Lakes:					
Sample size	34	67	49	-----57-----	
<i>Coefficient</i>					
Gross cash income	9.70	9.41	3.92	-----5.49-----	
Cash operating expense	17.72	9.16	6.60	-----8.05-----	
Net farm income	395.66	26.22	17.14	-----19.74-----	
Farm and nonfarm income	16.75	11.82	11.02	-----18.32-----	
<i>Number</i>					
West Coast:					
Sample size	-----75-----			36	46
<i>Coefficient</i>					
Gross cash income	-----13.94-----			7.27	28.31
Cash operating expense	-----13.08-----			7.58	32.47
Net farm income	-----358.19-----			14.26	191.00
Farm and nonfarm income	-----39.91-----			10.07	280.19

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B7—Coefficients of variation for income measures per cultivated crop farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Number</i>					
Northeast Coast:					
Sample size	33	60	62	116	116
<i>Coefficient</i>					
Gross cash income ²	12.65	8.03	3.91	3.38	18.08
Cash operating expense ³	20.78	13.54	6.85	5.41	11.05
Net farm income ⁴	106.04	59.90	24.86	26.30	35.71
Farm and nonfarm income ⁵	53.08	30.00	18.81	18.51	32.71
<i>Number</i>					
Southeast Coast:					
Sample size	69	128	79	129	220
<i>Coefficient</i>					
Gross cash income	8.23	11.41	3.56	4.54	7.46
Cash operating expense	39.28	27.41	18.35	6.17	8.41
Net farm income	52.11	306.48	49.24	15.44	26.48
Farm and nonfarm income	14.84	30.29	22.51	1.54	27.07
<i>Number</i>					
Gulf Coast:					
Sample size	73	198	112	252	333
<i>Coefficient</i>					
Gross cash income	13.55	6.32	4.01	2.30	11.10
Cash operating expense	11.18	9.00	6.23	3.16	9.65
Net farm income	49.66	198.72	100.14	19.27	27.66
Farm and nonfarm income	20.55	21.19	40.75	13.43	25.17
<i>Number</i>					
Great Lakes:					
Sample size	99	338	293	540	437
<i>Coefficient</i>					
Gross cash income	7.43	3.96	1.81	1.60	3.69
Cash operating expense	8.77	4.29	2.65	2.43	4.17
Net farm income	74.61	22.11	9.85	7.22	9.68
Farm and nonfarm income	22.48	7.22	6.14	5.86	8.66
<i>Number</i>					
West Coast:					
Sample size	-----85-----		47	130	233
<i>Coefficient</i>					
Gross cash income	-----15.34-----		10.65	6.66	8.82
Cash operating expense	-----8.77-----		8.71	8.15	9.12
Net farm income	-----111.24-----		82.02	13.95	18.68
Farm and nonfarm income	-----16.27-----		28.87	6.93	17.17

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B8—Coefficients of variation for income measures per irrigated farm, by coastal region

Item	Economic class ¹			
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999 \$250,000 or more
Northeast Coast:				
No farms profiled				
Southeast Coast:				
Sample size	Number			47
	Dollars			
Gross cash income ²	26.29			13.44
Cash operating expense ³	26.09			13.78
Net farm income ⁴	16.04			33.34
Farm and nonfarm income ⁵	22.11			29.28
Gulf Coast:				
Sample size	Number			209
	Dollars			
Gross cash income	12.48		3.04	9.04
Cash operating expense	14.66		4.46	8.76
Net farm income	62.73		25.48	18.69
Farm and nonfarm income	54.24		20.49	16.08
Great Lakes:				
Sample size	Number			77
	Dollars			
Gross cash income	15.82			9.97
Cash operating expense	13.03			10.58
Net farm income	50.73			16.13
Farm and nonfarm income	30.58			14.51
West Coast:				
Sample size	Number			280
	Dollars			
Gross cash income	13.30	7.63	4.62	10.14
Cash operating expense	8.32	8.35	10.32	11.36
Net farm income	186.99	58.55	28.57	21.12
Farm and nonfarm income	15.21	37.21	11.99	18.61

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B9—Coefficients of variation for income measures per combined dairy farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
<i>Number</i>					
Northeast Coast:					
Sample size	-----61-----		43	88	86
<i>Coefficient</i>					
Gross cash income ²	-----14.08-----		5.64	4.02	6.99
Cash operating expense ³	-----15.90-----		7.11	5.03	9.23
Net farm income ⁴	-----155.21-----		15.47	26.51	19.98
Farm and nonfarm income ⁵	-----42.32-----		13.70	20.22	18.48
<i>Number</i>					
Southeast Coast:					
Sample size	38	40	-----62-----		145
<i>Coefficient</i>					
Gross cash income	10.43	30.64	-----10.74-----		9.97
Cash operating expense	11.93	15.49	-----14.70-----		11.89
Net farm income	38.51	92.62	-----37.91-----		19.98
Farm and nonfarm income	12.37	25.69	-----19.20-----		17.56
<i>Number</i>					
Gulf Coast:					
Sample size	32	50	-----94-----		154
<i>Coefficient</i>					
Gross cash income	12.57	8.86	-----10.04-----		27.91
Cash operating expense	14.76	15.52	-----11.93-----		12.79
Net farm income	74.07	112.50	-----38.36-----		52.48
Farm and nonfarm income	64.09	18.66	-----14.11-----		43.62
<i>Number</i>					
Great Lakes:					
Sample size	-----126-----		141	301	272
<i>Coefficient</i>					
Gross cash income	-----8.73-----		1.91	2.00	5.62
Cash operating expense	-----7.42-----		3.44	3.16	6.50
Net farm income	-----52.52-----		12.79	9.55	13.55
Farm and nonfarm income	-----11.85-----		8.97	7.90	11.93
<i>Number</i>					
West Coast:					
Sample size	-----38-----		-----40-----		134
<i>Coefficient</i>					
Gross cash income	-----18.01-----		-----9.47-----		15.82
Cash operating expense	-----15.87-----		-----7.33-----		18.38
Net farm income	-----276.84-----		-----42.23-----		24.62
Farm and nonfarm income	-----17.24-----		-----32.34-----		22.23

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

Appendix table B10—Coefficients of variation for income measures per combined swine farm, by coastal region

Item	Economic class ¹				
	\$2,500-9,999	\$10,000-49,999	\$50,000-99,999	\$100,000-249,999	\$250,000 or more
Northeast Coast:					
No farms profiles					
<i>Number</i>					
Southeast Coast:					
Sample size	-----34-----			-----48-----	
<i>Coefficient</i>					
Gross cash income ²	-----15.62-----			-----5.82-----	
Cash operating expense ³	-----14.61-----			-----8.30-----	
Net farm income ⁴	-----93.82-----			-----21.81-----	
Farm and nonfarm income ⁵	-----36.81-----			-----22.97-----	
<i>Number</i>					
Gulf Coast:					
Sample size	-----		-----55-----		
<i>Coefficient</i>					
Gross cash income	-----		-----21.42-----		
Cash operating expense	-----		-----24.61-----		
Net farm income	-----		-----109.83-----		
Farm and nonfarm income	-----		-----37.57-----		
<i>Number</i>					
Great Lakes:					
Sample size	-----40-----		40	88	82
<i>Coefficient</i>					
Gross cash income	-----8.07-----		8.30	4.18	6.32
Cash operating expense	-----8.70-----		7.81	5.21	6.55
Net farm income	-----183.01-----		33.07	14.79	18.50
Farm and nonfarm income	-----14.68-----		17.26	11.02	17.52
West Coast:					
No farms profiled					

¹Sales of crops and livestock products. ²Gross cash income includes livestock sales, crop sales (including net CCC loan proceeds), government payments, and other farm-related income. ³Cash operating expenses include all variable and fixed cash expenses. ⁴Net farm income is gross cash income less cash expenses, less depreciation and noncash benefits, plus inventory change and nonmoney income. ⁵Farm and non-farm income is net farm income, off-farm income, and income from other farm operations.

Source: U.S. Department of Agriculture, Farm Costs and Returns Survey, special tabulations.

SUMMARY OF REPORT #AER-701

New Report Presents Benefits of Improving Rural Water Quality

January 1995

Contact: Stephen Crutchfield, (202) 219-1020

Concerns about the potential impact of farm production on the quality of the Nation's drinking and recreational water resources have risen over the past 10 years. Agricultural sources are now the largest single contributor to the Nation's surface water quality problem, and there is evidence that some ground water supplies may be vulnerable to leaching chemicals in agricultural areas, according to *The Benefits of Protecting Rural Water Quality: An Empirical Analysis*. This new report from USDA's Economic Research Service explores the use of nonmarket valuation methods, such as travel cost to a recreational lake, to estimate the benefits of improving or protecting rural water quality from agricultural sources of pollution.

Food and fiber production can impair surface and ground water resources. Fertilizers and pesticides used to grow crops may leach through soils and contaminate ground water supplies. Dissolved chemicals in drinking water may then pose a human health risk. Runoff of chemicals from sediment and cropland, as well as soil erosion, may impair the quality of streams, lakes, rivers, and wetlands. Most early efforts to protect water quality were directed at municipal and industrial sources of pollution, where a single pollutant source could be identified (point-source pollution). The cumulative effect of more than 20 years of investment in such point-source pollution control is that nonpoint-source pollution, particularly from agricultural sources, has become the largest single remaining water quality problem in the Nation.

Both public and private costs are relevant in resolving conflicts between agriculture and water quality. When making production decisions, farmers balance their expected production costs with expected returns from crops produced. However, farmers' decisions may have unintended long-range effects.

Economic losses from impaired water quality reflect, in part, how important the resources are to society (see table). One case study is used to illustrate the relationship between agricultural production and the costs of im-

paired surface water quality. Changes in farm production practices may lead to changes in the quality of nearby lakes, affecting recreational opportunities. A case study of lakes in Minnesota shows the economic benefits of reducing soil erosion and improving lake clarity. Another case study shows the regional benefits of protecting ground water from agricultural chemicals. Using survey data from USDA's Area Studies Program, estimates of willingness to pay for ground water protection are developed for four specific regions.

Some of the approaches that can be applied to valuing water resources are discussed, and a historical review of previous studies shows how the procedures and methods for valuing water quality benefits have evolved in recent years. Estimated water quality benefits associated with policies and programs that prevent pollution can be used to more comprehensively assess the overall benefits and costs of farm policies.

To Order This Report...

The information presented here is excerpted from *The Benefits of Protecting Rural Water Quality: An Empirical Analysis*, AER-701, by Stephen R. Crutchfield, Peter M. Feather, and Daniel R. Hellerstein. The cost is \$9.00.

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Types of benefits from improving rural water quality

Benefit class	Benefit category	Examples
Use value	In-stream services	Recreational uses such as swimming, boating, and fishing. Commercial/municipal uses, such as fishing, navigation, and water storage facilities.
	Consumptive services	Drinking water from municipal water systems and private wells. Irrigation and other agricultural uses.
	Aesthetic value	Near-water recreation, such as sightseeing, and property value enhancement.
	Ecosystem value	Preservation of wildlife habitat and promotion of ecosystem diversity.
Nonuse value	Vicarious consumption	Value placed on enhanced use of clean water by others.
	Option value	Desire to preserve opportunity to enjoy clean water at some future time.
	Stewardship value	Protection of environmental quality and desire to improve water quality for future generations.



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Agricultural and Water-Quality Conflicts: Economic Dimensions of the Problem. *Research report.* 18 pp. July 1993. **Stock # AIB-676. \$9.00.** Summarizes conflicts between agricultural production and water quality, and discusses policies that stress the use of economic and technical assistance incentives to encourage adoption of pollution-reducing farm practices.

Cotton Production and Water Quality: Economic and Environmental Effects of Pollution Prevention. *Research report.* 44 pp. December 1992. **Stock # AER-664. \$9.00.** Finds that environmental damage to surface and ground water posed by cotton farming may be reduced, with only limited effects on yields and prices, if restrictions on agrichemical use or production are applied to just those acres most vulnerable to water-quality problems.

Estimating Water Quality Benefits: Theoretical and Methodological Issues. *Research report.* 28 pp. September 1992. **Stock # TB-1808. \$9.00.** Reviews practical approaches and theoretical foundations for estimating the economic value of changes in water quality to recreation, navigation, reservoirs, municipal water treatment and use, and roadside drainage ditches.

Global Review of Resource and Environmental Policies: Water Resource Development and Management. *Research report.* 90 pp. June 1994. **Stock # FAER-251. \$12.00.** This report reviews how 30 countries develop and manage their water resources. Because the focus of the report is on agriculture, particular attention is given to irrigation.

Point-Nonpoint Source Trading for Managing Agricultural Pollutant Loadings: Prospects for Coastal Watersheds. *Research report.* 24 pp. September 1993. **Stock # AER-674. \$9.00.** Shows that "trading" cleanup efforts among pollution sources would allow a polluting firm to sponsor pollution controls elsewhere in a watershed rather than install controls of its own.

Public Policies in Water-Resource Use: Their Effect on Groundwater Mining and Surface-Water Imports. *Research report.* 35 pp. July 1989. **Stock # TB-1764. \$9.00.** Analyzes the effect of public policies on the rate of groundwater use and on the timing of surface water transported into an area to satisfy regional water demand.

Economic Benefit Considerations in Selecting Water Quality Projects: Insights from the Rural Clean Water Program. *Staff report.* 36 pp. May 1989. **Stock # AGES 8918. \$9.00.** Finds that projects under the Rural Clean Water Program that preserve or improve water quality in a heavily used lake or estuary appear to have the greatest potential for generating net benefits.

Agricultural Irrigation and Water Use. *Research report.* 128 pp. January 1992. **Stock # AIB-638. \$15.00.** Uses tables and graphics to illustrate how each State distributes, uses, and manages its water resources.

Water Allocation Tradeoffs: Irrigation and Recreation. *Research report.* 21 pp. June 1990. **Stock # AER-634. \$9.00.** Develops a procedure for estimating the marginal value of water used for fishing that includes the effects of upstream diversions on all points downstream.